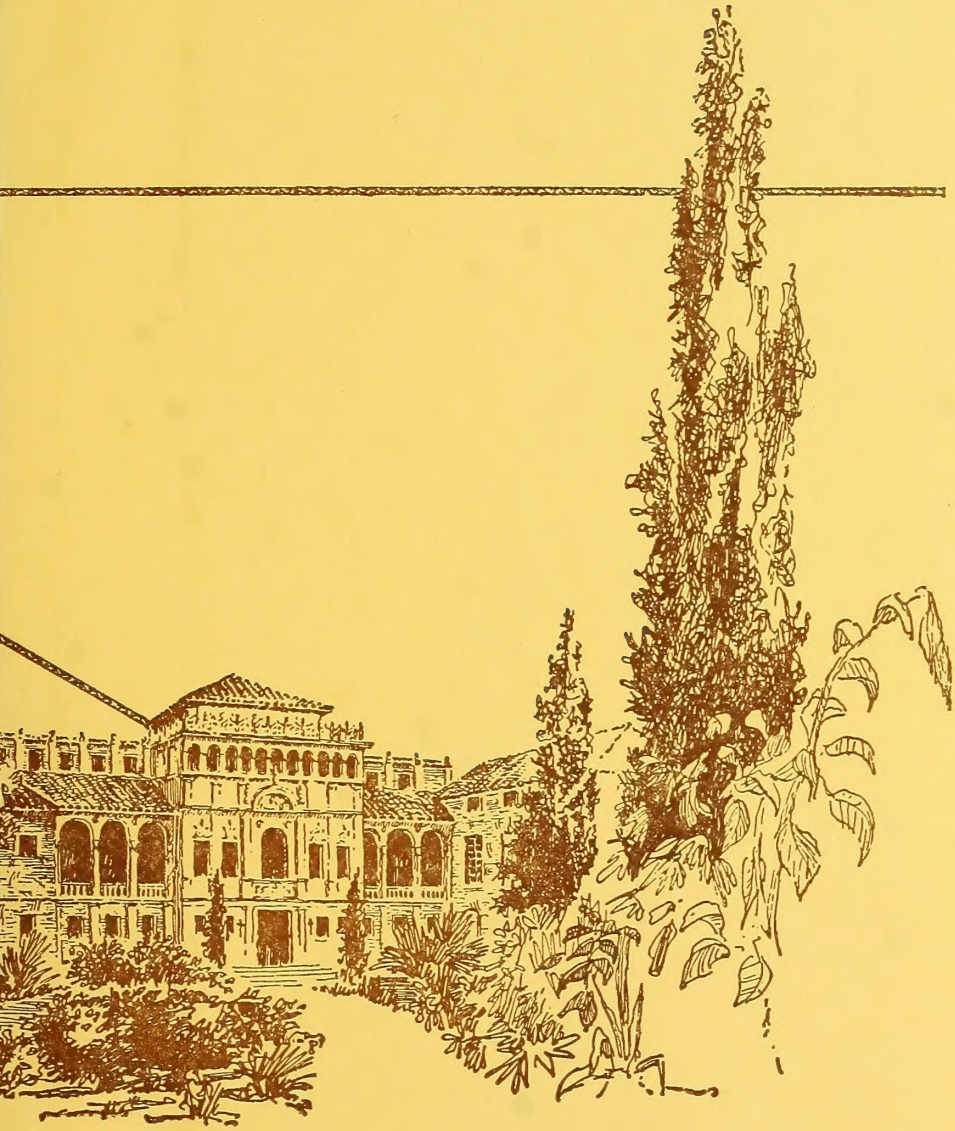
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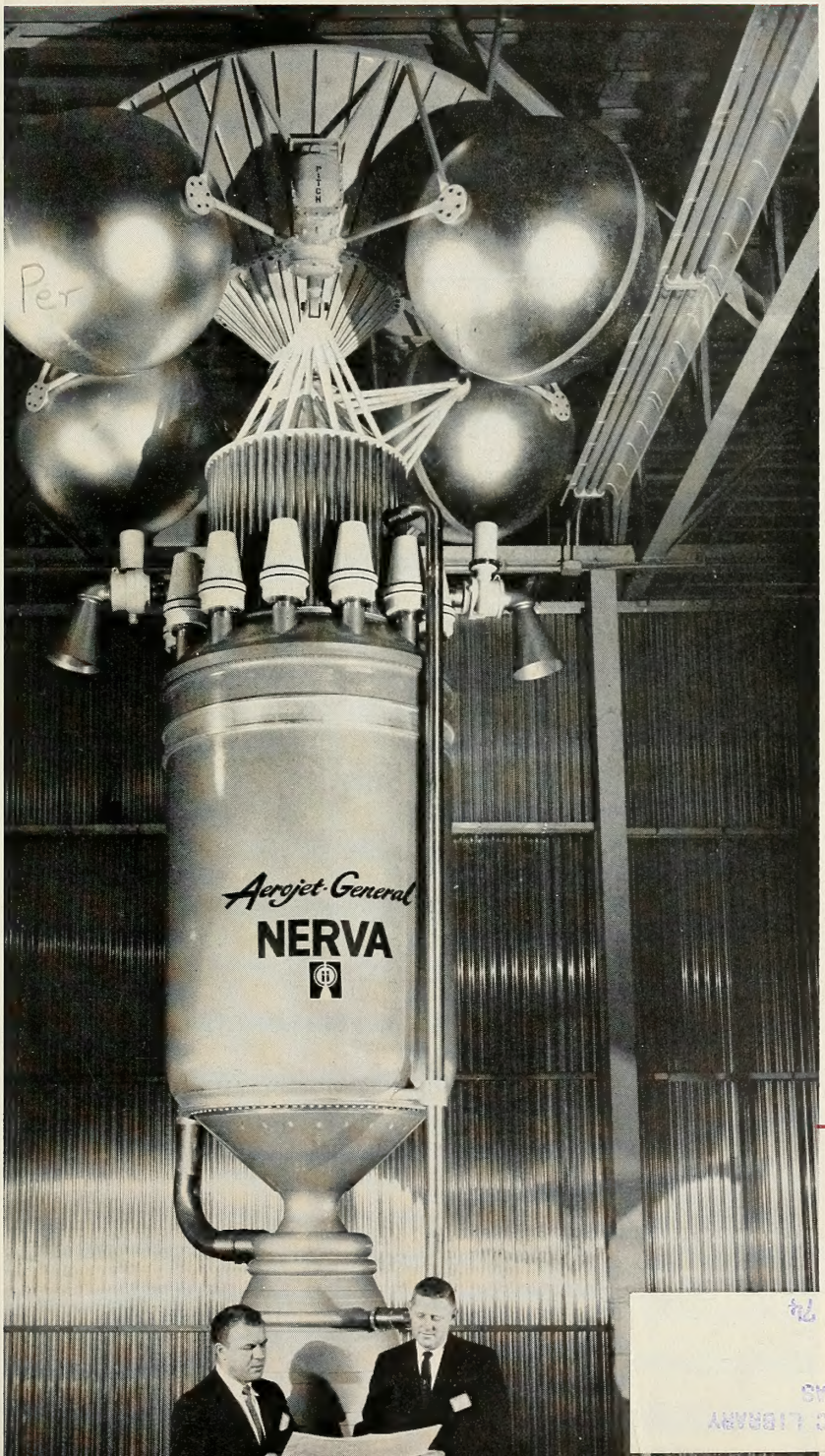
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WEEKLY OF SPACE SYSTEMS ENGINEERING

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COSPAR Hears U.S., USSR Space Launching Plans

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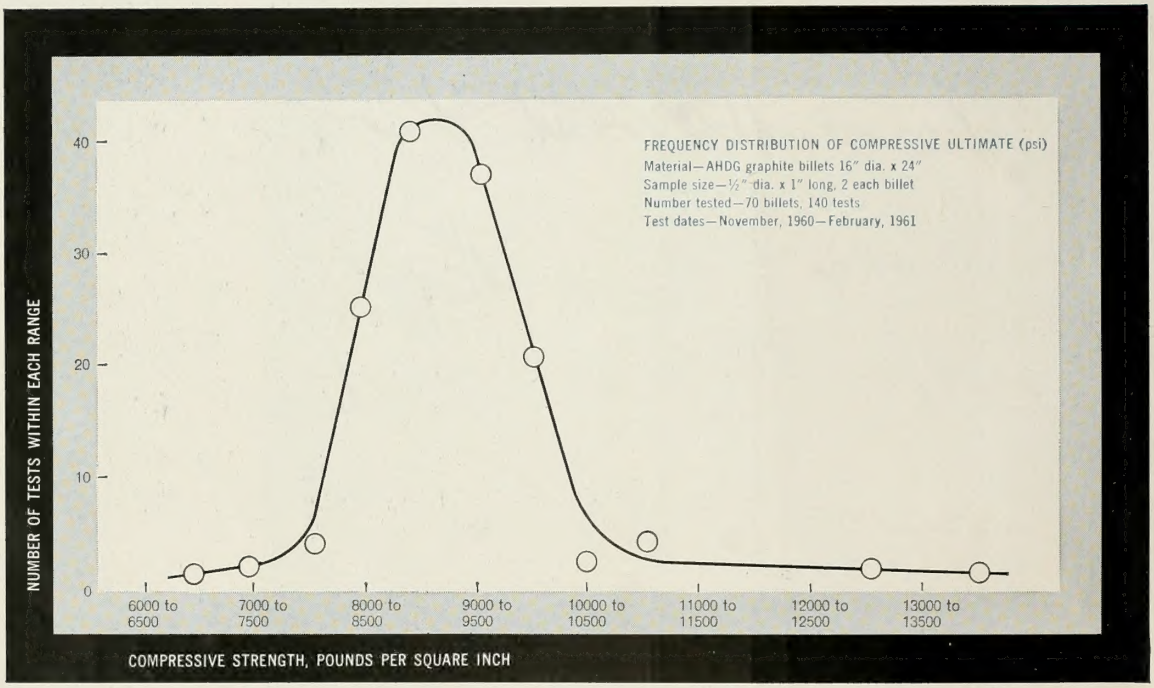
Aerojet's NERVA Mock-up

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Now the Bell System integrates switching and transmission in a new digital communications system

Right now transmission and switching of communications are *separate* functions. They are usually performed by space-divided processes.

However, the development by Bell Telephone Laboratories of an experimental high-speed electronic model called ESSEX (for Experimental Solid State EXchange) may change all of this. And it may revolutionize military as well as civilian communications systems.

ESSEX works on a *time-division* principle. For the first time, it integrates both transmission and switching.



Above is an over-all view of the ESSEX (Experimental Solid State EXchange) research model set up at Bell Laboratories. Units behind the control console are only half of the total equipment.

Faster, more efficient service

By harnessing time, ESSEX may introduce the following revolutions in communications:

More messages can be transmitted on fewer lines. Through the use of Pulse-Code Modulation (PCM), signals are converted into coded, digital pulses. These pulses are carried at high speeds to their destinations on just a few lines and are then reconverted to standard signals for delivery.

Central office switching networks can be much smaller. The PCM conversion is done at special "concentrators" close to a number of customers. Today every telephone is connected to a central office by two wires. By consolidating many signals on a few lines, the "concentrators" will allow central office switching networks to be much more compact.

Promising Development

Although full-scale use of ESSEX is still in the future, it shows how Bell System developments arising out of basic research can pyramid into extraordinary communications advances.

ESSEX becomes practical through Bell Laboratories' discovery of the transistor and developmental work with semiconductor devices. What ESSEX will lead to—in both military and civilian communications—only the future can tell.

This is another example of the Bell System's continuing efforts to improve communications techniques and services.

Bell Telephone System

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THE WEEKLY OF SPACE SYSTEMS ENGINEERING

missiles and rockets

Volume 10, Number 19 May 7, 1962

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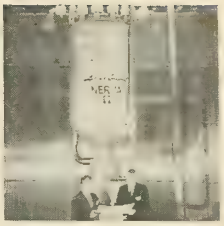
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THE COVER

First released photo of Aerojet-General's full-scale wooden mock-up of the NERVA nuclear rocket engine, being built by the firm at its Azusa, Calif., plant. See p. 11.



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†U.S. Reg. Pdg.

39,954 copies this issue

Cost of Contracting

To the Editor:

Thank you so very much for the April 16 editorial ("Those Lush Defense Profits").

Someone should explain to the public what it costs just to prepare a *bid* on a proposed contract, and how the contractor has to do the work for the services in exploiting a new concept.

George E. Barnhart
Flight Path Control Co.
Altadena, Calif.

'Applied Scientists'

To the Editor:

Mr. T. J. Nawrocki's letter ("Who's An Engineer?", M/R, April 16, p. 6) opens up another important phase of the controversial shortage of engineers.

A few months ago, two or three persons at Redstone Arsenal were discharged due to falsifying of their records wherein they claimed they were graduate engineers—claimed degrees from recognized colleges and were given top jobs. How did they get in in the first place? Is it because they were under 40 years of age? And knew the right person?

But how many more non-engineers have been upped to an engineer's status just because they may have been good draftsmen and through years of service were finally made into engineers for increased pay purposes?

These men are not to be blamed for their false status—it is the loose system that has become prevalent in this country in the use of the word "engineer."

Of course, there are always exceptions to the rule, but it is seriously doubted if any of these so-called engineers have the vision to develop a new idea, to "see" in their minds the necessary steps in planning prototype equipment.

Those non-graduates who are the exception to the rule should do as Mr. Nawrocki suggested in his letter—that is, pass a "Final" examination on the subjects they are so well versed in, at a recognized college, and be awarded full credit toward a degree.

Yet, there are so many graduate engineers past 45 years but under 65 years who are being discriminated against in employment in the U.S. that it will soon become a national shame. Our Government should lead the way in the use of graduate engineers—clean out its own shelves where it has placed men of unprofessional attitude and nonproductive vision.

Basically, our Government is creating confusion and frustration in its educational program—on the one hand it is allocating huge sums of money to develop men to work in the sciences, and on the other hand it is throwing away trained "old" men who could fill the gap until a new *trained* crop is ready to take their place.

As long as medical science is extending the life span of man, Government and Industry will have to extend their working years—especially those of the men who have the vision to be engineers, i.e., *Applied Scientists.*

Harold A. Weinbaum
Prof. Mechanical Engineer,
i.e., Applied Scientist

Hails Reliability Symposium

To the Editors:

Let's define this new technology of reliability. Note here, technology, not science. For reliability is a study of techniques and applications. It is not at the stage of development of Newtonian Mechanics, but is still a young art more akin to emerging technologies like molecular electronics and vapor-deposited micromodules. No one has yet defined the laws of part operational life so that we can concretely predetermine the correlations of accelerated life tests. No one knows (yet) how to invariably accelerate aging of a part or component so that we can give an absolute true measurement of its life expectancy. We are all "babes in the woods" when it comes to absolute prediction of a system's reliability. Some of us don't believe it's possible, others of us declare it's a useless expenditure of effort. But we're earnest and we're trying and we're learning. It is my contention that reliability will grow from a technology to a science faster than any science in the history of mankind—because we *know* we *have* to.

Food for thought: How many ten-year-olds speak fluently of the calculus of finite integrals?

So here I say: Behold the IAS National Aerospace Systems Reliability Symposium, Salt Lake City: Here's an example of what can be accomplished when a group of serious men get together to honestly exchange ideas and concepts with the common interest of improving the state of the art.

Roses to Richard W. Flygare, General Chairman, and to all members of the IAS, for a job well done.

M. J. Ciarlariello
Member, ARS
Tacoma, Wash.

Defense of Las Vegas

To the Editor:

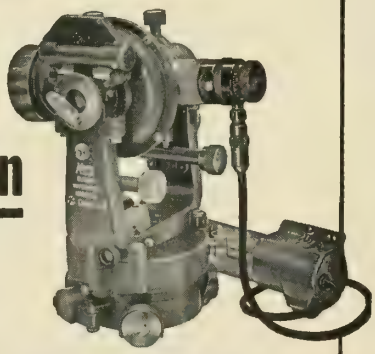
I am sorry to see that you, along with many others, believe that all Las Vegas has is "neon signs and scantily-clad girls." Although it may come as a shock and a surprise to you, there is a considerable amount of research being carried on in Las Vegas, and this has nothing to do with

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the odds of the gambling tables.

Despite your comments in your "The 50-Megaton Miracle" editorial (M/R, April 2), Las Vegas is ideally suited for meetings such as that of the Air Force Association. Your caustic comments should perhaps be directed at a few juvenile members of these associations, rather than at the city of Las Vegas itself.

Paul D. Pattinson
Manager, Administrative Services
Edgerton, Germeshausen & Grier, Inc.
Las Vegas, Nev.

Muse Revived

To the Editor:

Re J. P. Davis's "Lights of Perth—I" (Letters, M/R, April 16):

I had no idea a space hardware magazine would invoke the Ninth Muse, even for a good poem. Speaking of good poetry, allow me to present some lines composed at Cape Canaveral in 1957:

Reliability's Mournful Howl—
or Lines Penned at Canaveral on Eve of Vanguard I

On Hesitation's tardy beach,
By Cape's Malfunction Junction,
The bones of counting thousands bleach
Who counted down & died to teach
Us ne'er to trust
Untried components' function.
Gently, brother, gently pray,
Step tenderly o'er the bones of they
Who push the button.

Joaquin Molinero El Conscripto
(Webb Miller)
BSME, Exec. Secy., Lafcadio Hearn Society
Ancient Countdowner
Poet of Cislunar Space
Canoga Park, Calif.

P.S. This is not plagiarism; it's research. I borrowed lines from several sources.

The Space Gourmet's Guide

When you are eating weightlessly
Remember crumbs with zero g
Cannot be blown or swept away
Under the rug: Aloft they stay.
There are no cans for trash in orbit
Or vacuum cleaners to absorb it.
'Tis better to select with care
The foods you plan to swallow there—
They can be tender, tough or gummy
As long as they do not get crumby.
No muffin, cruller, bun or roll
(Unless you plan to eat it whole).
Avoid all residues as well—
The egg, the clam, the peanut shell;
The peach pit and the orange peel;
The crust, the rind, the skin, the heel;
The bones of fowl or other critters—
An Astro-diner never litters.
Now that I've given you the cue
A cleaner space is up to you.

J. P. Davis
Nuclear Engineer
Burns & Roe, Inc.
New York

Increased technical responsibilities in the field of range measurements have required the creation of new positions at the Lincoln Laboratory. We invite inquiries from senior members of the scientific community interested in participating with us in solving problems of the greatest urgency in the defense of the nation.

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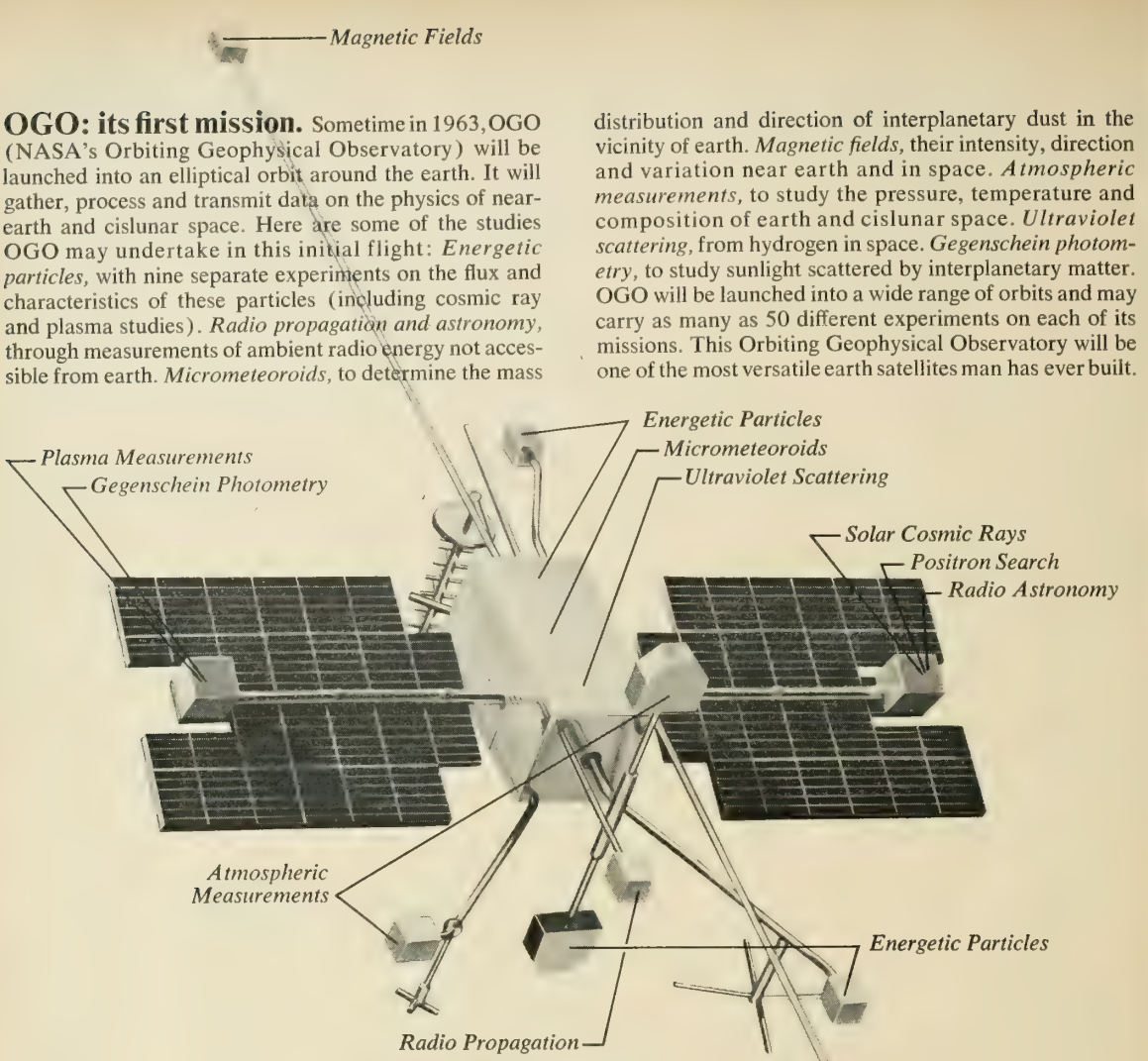
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OGO: its first mission. Sometime in 1963, OGO (NASA's Orbiting Geophysical Observatory) will be launched into an elliptical orbit around the earth. It will gather, process and transmit data on the physics of near-earth and cislunar space. Here are some of the studies OGO may undertake in this initial flight: *Energetic particles,* with nine separate experiments on the flux and characteristics of these particles (including cosmic ray and plasma studies). *Radio propagation and astronomy,* through measurements of ambient radio energy not accessible from earth. *Micrometeoroids,* to determine the mass distribution and direction of interplanetary dust in the vicinity of earth. *Magnetic fields,* their intensity, direction and variation near earth and in space. *Atmospheric measurements,* to study the pressure, temperature and composition of earth and cislunar space. *Ultraviolet scattering,* from hydrogen in space. *Gegenschein photometry,* to study sunlight scattered by interplanetary matter. OGO will be launched into a wide range of orbits and may carry as many as 50 different experiments on each of its missions. This Orbiting Geophysical Observatory will be one of the most versatile earth satellites man has ever built.



** Captions indicate possible arrangement of instrumentation clusters which OGO may carry.*

OGO: its challenge. Today OGO demands advanced techniques in spacecraft design and development to meet its need for flexibility. It is a challenging responsibility to STL engineers, scientists and supporting personnel, who design it, fabricate it, integrate it, and test it. This versatile spacecraft will be manufactured at STL's vast Space Technology Center where expanding space projects (OGO, Vela Hotel and other programs) create immediate openings for engineers and scientists in fields such as Aerodynamics; Spacecraft Heat Transfer; Analog and Digital Computers; Applied Mathematics; Electronic Ground Systems; Power Systems; Instrumentation Systems; Propellant Utilization; Propulsion Controls; System Analysis; Thermal Radiation; Trajectory Analysis. For Southern California or Cape Canaveral positions, write P. O. Box 95005, One Space Park, Department — B, Redondo Beach, California, or P. O. Box 4277, Patrick AFB, Florida. STL is an equal opportunity employer.

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The Countdown

WASHINGTON

Centaur Ready Again

NASA has set May 9 as the new date for first launch of the *Centaur* vehicle. The last attempt, on April 22, was scrubbed when the umbilical cord on the launch pad failed to drop away.

Gemini Moon Orbit Doubtful

Present plans call for permitting the *Gemini* astronauts to get out of their spacecraft and move around during their Earth-orbital missions. Looking further ahead, some NASA officials are proposing that one of the last missions for the two-man craft should be a lunar orbit. This would present serious booster and heat-shielding problems, however, and such a mission now looks unlikely.

Titan III Contract Talk

Reports circulated in the Pentagon last week that the long-deferred contract for the 120-in. solid booster for *Titan III* was imminent—and likely to go to either UTC or Aerojet. As of M/R's press time, there was no confirmation of these rumors. Meantime, there were also persistent reports—from usually reliable sources—that STL would receive the *Titan III* guidance award.

INDUSTRY

Brown Sees A-ICBM Gap

The United States is six months to a year behind the Soviet Union in development of an antimissile missile, following Soviet A-ICBM tests against ballistic weapons. That is assessment of Dr. Harold Brown, the Defense Department's research and engineering director, voiced during a radio interview.

Navy Gets First Shrikes

Texas Instruments has delivered to the Navy the first two prototypes of its short-range, electromagnetic antiradiation air-to-ground *Shrike* missile. The *Shrike* contract calls for research and engineering and pre-production development. A production follow-on contract is expected. Unlike the Air Force, the Navy has no funds for an antiradiation version of Martin's *Bullpup*.

More Space Lab Funds

North American Aviation has received a four-month extension of its $100,000 NASA feasibility contract for study of a self-erecting space laboratory (see p. 14). NAA's Space and Information Systems Div. will build a one-tenth-scale model of the 150-ft.-dia. design. The Air Force is interested because of the lab's possible application as a military test space station.

S-4's Nearly Complete

First production *S-4* vehicles for the second stage of *Saturn C-1* are now in final assembly at Douglas Aircraft's Santa Monica, Calif., plant. Initial ground-firing of the *S-4* is scheduled for May. The first two-stage *Saturn* flight is slated for July, 1963.

Apollo Mock-ups Pressed

Despite the recently disclosed systems engineering review of NASA's *Apollo* mission, North American Aviation is pushing rapidly ahead with construction of mock-ups. The timetable calls for completion of mock-ups by October.

Pre-Marital Stress

The merger of the Institute of the Aerospace Sciences and the American Rocket Society now appears certain. There still are minor differences which must be worked out before the agreement is completed. These could mean months of delay before the merger is consummated.

INTERNATIONAL

Mixed Emotions over Ariel

Last week's successful launch of the U.S.-U.K. *Ariel* satellite—first international satellite—got big headlines in all British papers. But engineers and administrators meeting at the Rocket Propulsion Symposium at Cranfield did not find the news so thrilling, it was reported. They were aware that while the satellite package was British-made, the real effort lay in the launching.

NATO To Train Missilemen on Crete

NATO has decided to use a rocket training center on the island of Crete. The multimillion-dollar installation will be used initially by West Germany, the U.S., France, Belgium, the Netherlands, Norway and Denmark. Part of the preliminary study with the Greek government was reportedly conducted by Ralph Parsons Co., of Los Angeles, represented by Gen. James Van Fleet (USA-Ret.), Van Fleet, now a Parsons Co. vice president, commanded U.S. advisory troops in Greece more than a decade ago.

British Team After Ranger Men

Officials from the British Civil Service Commission and Atomic Energy Authority are now in the U.S. trying to persuade British research students to return home. They expect to see about 200 students who have American university scholarships or are working for NASA (several are engaged in the *Ranger* program).

Thiokol Organizes for Big Solids

The "Alpha Division", composed of existing operations at Huntsville and a new solid rocket facility in Camden County, Ga., will form a new organizational segment of the Thiokol Chemical Corp. under the firm's Rocket Operations. The booster plant to be built at the Camden site will handle motors up to 40-ft.-dia. and will be under general manager J. W. Wiggens, former head of the Redstone Division. An executive staff, including a cadre of big booster engineers, will be moved to an administration building near the Camden site. The firm also received an additional $6.9 million in Army funds for *Sergeant, Pershing* and *Nike-Hercules* motors at the Longhorn, Tex., Division.

New NASA Research Chief

Dr. Raymond L. Bisplinghof has been named Director of NASA's Office of Advanced Research and Technology.

The new NASA official formerly served as Professor of Aeronautical Engineering at Massachusetts Institute of Technology.

Earlier, he was associated with the Aeronca Aircraft Corp.

Shots of the Week

• NASA pilot Joe Walker shoved the *X-15* to a new altitude record of 48 miles April 30, using an 81-sec. engine burning time and a 38° climb angle. Peroxide steam jets were used to position the North American *X-15* for the dive phase after the climb. Walker "bellied" into the thicker atmosphere layer by pulling the nose up during the 3000-mph dive. The maneuver resulted in about a 5-g force on the pilot. The Thiokol XLR-99 engine had about 9 seconds of burning time left at shut-off, which would have put the *X-15* above 300,000 ft.

• All three stages of an Army-Western Electric *Nike-Zeus* anti-missile missile performed perfectly in a test flight over the White Sands Missile Range on April 27.

• The first international satellite was launched April 26, using a U.S. *Thor-Delta* booster and a British payload. Six British experiments were aboard the 132-lb. satellite. Dubbed *Ariel,* the package is performing according to plan, say British officials.

• The Soviets orbited *Cosmos IV* April 26, but declined to describe its mission in detail. The satellite carried "cosmic space investigative apparatus." *Cosmos IV* landed in a pre-selected site in the USSR after a 1.25-million-mile flight. This was the first of four such satellites designed to be returned to earth after orbit, Tass reported.

• Two more secrecy-shrouded satellites were launched April 26 from Point Arguello, Calif., by the Air Force. One used a four-stage *Blue Scout* booster and the other was powered by an *Atlas Agena B.* The lighter shot may have been connected with the current series of nuclear tests in the Pacific. The *Atlas* combination is capable of a *Samos* or *Midas* launch.

• The Army fired a Martin *Pershing* missile down a planned short-range trajectory from Canaveral April 27. The launching marked the 30th success in 35 attempts.

• Launching of a *Nike-Cajun* rocket from Wallops Island April 26 opened the U.S.-Japan cooperative space exploration program. Payload included a U.S. Langmuir probe and Japanese-developed instruments to measure electron temperature and density in the ionosphere.

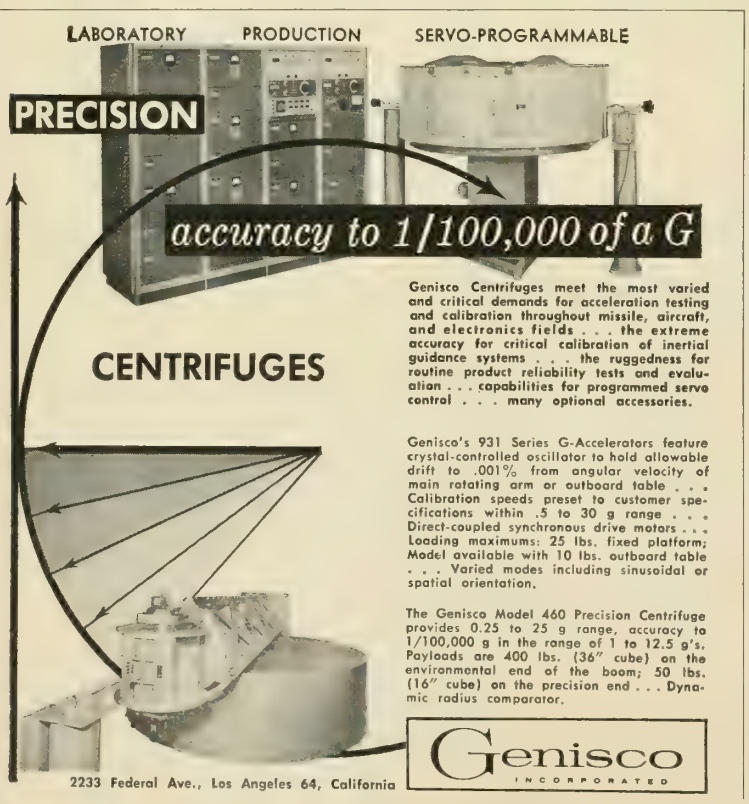
BOB Report on R&D Contracts

The Bureau of the Budget report on "Government Contracting for Research and Development" has been approved by President Kennedy for action by government departments.

The President, Budget Bureau Director David Bell reports, has directed government agencies to implement the Bureau's recommendations and report back to him within six months.

Noting that Federal R&D expenditures have been increasing "at a phenomenal rate," the report concludes that "it is in the national interest for the government to continue to rely heavily on contracts with non-Federal institutions to accomplish scientific and technical work needed for public purposes."

However, the report makes it clear that the government should take extraordinary efforts to insure



that it has a strong in-house capability to technically manage R&D work —and in some cases perform such work on its own. The report notes that "in recent years there has been a serious trend toward eroding the competence of the Government's research and development establishments."

To correct this, it recommends that government R&D establishments:

—Be assigned significant and challenging work.

—Simplify management to eliminate unnecessary echelons of review and supervision.

—Make their salaries more comparable with those available in private industry.

Although congressional action has been requested on this last point, the report also endorses controls over government contracts which would allow the contracting officer to "make sure that reasonable limits are applied" to salaries under cost-reimbursable contracts.

Copies of the report have been sent to both houses of Congress. They should receive close attention from the appropriations committees, which have in the past been extremely critical of the Defense Department's use of non-profit corporations for government R&D work.

Stahr Resigns Army Post

Secretary of the Army Elvis Stahr has resigned to accept the presidency of Indiana University. Best bet to replace him, say Pentagon sources, is Army Undersecretary Stephen Ailes.

The resignation, effective June 30, came after several denials of reports that he was planning to leave and was disappointed by the Administration decision not to seek pre-production money for the *Nike-Zeus,* as well as other Administration decisions.

About the Cover

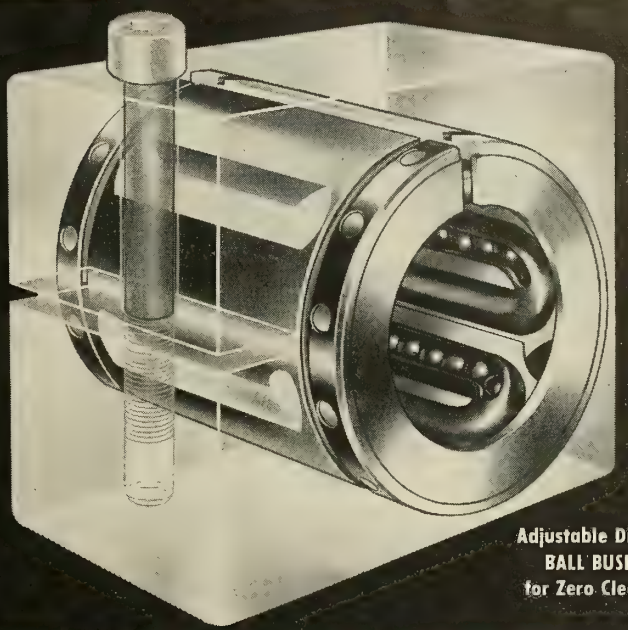
FULL-SCALE wooden mock-up of Aerojet-General's NERVA nuclear rocket engine is shown for the first time at company's Azusa, Calif., plant. In front of 25-ft.-tall model are (left) W. C. House, Aerojet's vice president-nuclear rocket systems, and Dr. C. H. Trent, associate director-NERVA operations.

NERVA will be flight-tested on a RIFT (Reactor In-Flight Test) vehicle atop an Advanced Saturn rocket in 1966-67. NASA is selecting a contractor for RIFT.

The NERVA reactor is being developed by Westinghouse Electric Corp., Aerojet's prime subcontractor.

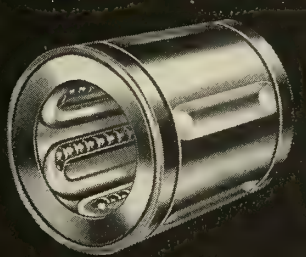
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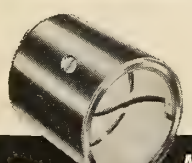
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U.S., Soviets Outline Plans

International group also hears far-ranging reports on results of space research

by William Beller

U.S. and Soviet plans for exploring space in 1962 seem to be cut from the same pattern—a growing number of manned shots mixed with new and more sophisticated satellite experiments.

The similarity became clear when spokesmen of both countries revealed part of their programs to world space scientists attending opening meetings of the Committee on Space Research (COSPAR) in Washington, D. C., last week.

These meetings also marked the first get-together of Russian astronaut Major Gherman S. Titov with American astronaut Lt. Col. John Glenn. Both were scheduled to address the life sciences session.

Earlier, Titov told the Overseas Press Club in New York that his spacecraft *Vostok II* landed intact and with little damage. Amplifying this remark, he later informed a television audience that he landed separately from his craft by means of an ejection seat and parachute.

After his COSPAR talk, Titov was scheduled to visit President Kennedy.

COSPAR was established in October, 1958, by the International Council of Scientific Unions to continue the rocket and satellite programs of the International Geophysical Year. Since that time, the organization has annually brought the world's leading space scientists together for the interchange of data and to encourage mutually beneficial and cooperative space projects.

• **Varied harvest**—A few highlights of the various technical sessions:

—Titov's nausea during his weightless condition increased with sharp movements of his head, decreased when he limited his movements.

—Metal ions have been discovered in the upper atmosphere.

—A transition band of helium was also found in the upper atmosphere.

—It has been established that gravitational separation of argon and nitrogen starts at 110 km.

—An experiment confirmed the presence of a large number of radio-signal conducting ducts in the upper atmosphere.

—A new theory suggests that the upper atmosphere is heated through electromagnetic and corpuscular radiations.

—There is evidence that the upper atmosphere is experiencing a systematic decrease in temperature.

• **Soviet plans** — Soviet Academician Dr. A. A. Blagonravov, summarizing Russia's space activities in 1961 and

Soviet Satellites Launched in 1961

(According to Academician A. A. Blagonravov)

Launch Date — Lifetime	Weight-Kg	Perigee Apogee, Period, Inclination	Scientific Experiments
Feb. 4, 1961 to Feb. 26	6483	223 km 328 km 89.8 min 64.6°	The test of the systems of launching and the precise trajectory check.
Feb. 12, 1961 to Feb. 25	——	222 km 280 km 89.5 min 65°	The launching of an automatic interplanetary station to Venus from the satellite.
Feb. 12, 1961 —	643.5 — the weight of the Automatic Interplanetary Station	Toward Venus. Reached Venus at the second half of May, 1961. The minimum distance to Venus was 100,000 km and the distance covered 280 million km.	Investigation of interplanetary ionized gas and of solar corpuscular radiation belts and of space radiation. Magnetic measurments. Investigations of meteoritic dust. Radio communication on 922.8 Mc.
Mar. 9, 1961 — (lift-off and landing)	4700	183.5 km 248.8 km 88.6 min 64° 56′	The testing of the ship design and its systems aboard to prepare the manned space flight. Medico-biological experiment (the dog Chernushka). Successful descent and landing.
Mar. 25, 1961— (lift-off and landing)	4695	178 1 km 247 km 88.42 min 64° 54′	Testing of the ship and its systems aboard to prepare the manned space flight. Medico-biological experiment (the dog Zvyozdochka). Successful descent and landing.
Apr. 12, 1961 — (lift-off at 9h.07 min; landing at 10h.55 min)	4725	181 km 327 km 89.1 min 64° 57′	The first manned space flight in the world and successful landing at a prescribed area. Pilot Y. A. Gagarin. Radio communication on frequencies, 19.995 Mc, 9.019 Mc, 20.006 Mc, 143.625 Mc.
Aug. 6, 1961 — (9h.00 min— the lift-off; Aug. 7, 1961, 10h 18 min— the touch-down)	4731	185 km 244 km 88.46 min 64° 56′	The second Soviet manned space flight and successful landing in a prescribed area. Pilot cosmonaut G. S. Titov. Radio communication on frequencies 15.765 Mc, 19.995 Mc, 20.006 Mc, 143.625 Mc.

plans for 1962, noted in an off-hand way that "Medico-biological investigations will be continued during the next manned space flights." The statement was not amplified.

He also stated that a series of artificial Earth satellites will be launched during 1962, in line with a program of investigating the following physical phenomena:

—Charged particles in the ionosphere.

—Corpuscular streams and low-energy particles.

—The Earth's radiation belts.

—The geomagnetic field.

—Shortwave radiations of the sun and other space bodies.

—Cloud systems.

He added that the program also includes studying the structure of the upper atmosphere and an investigation of the effects of meteorites on spacecraft design. The four satellites of the *Cosmos* series—launched early this year—were named as part of the overall scientific program.

• **U.S. schedule**—The U.S. delegation, through General Electric Co.'s Richard W. Porter, outlined America's space plans for the balance of 1962 and early 1963. These include:

—Three manned orbital flights, some of 18 or more orbits.

—Two *Mariner R* planetary spacecraft sent on Venus fly-bys.

—Another *Ranger* spacecraft sent on a lunar-impact mission.

—Launching of the first of a series of *Nimbus* weather satellites.

—Launching of three more *Tiros* at approximately four-month intervals.

—Launching of four types of experimental communications satellites: *Echo II*, an inflatable, reflective sphere; *Telstar*, an active, wide-band, low-orbit communications repeater satellite; *Relay*, another type of active, wide-band, low-orbit repeater satellite; and *Syncom*, an active narrow-band repeater satellite in a 24-hour orbit.

—A seven-frequency ionosphere beacon placed in a polar orbit for worldwide ionospheric research.

—Launch of an interplanetary monitoring probe (*IMP*), a satellite to monitor continuously the radiation environment between Earth and moon—data especially important for manned lunar flights.

—An atmospheric-structure satellite to measure density, composition, pressure and temperature of the Earth's upper atmosphere.

—An energetic-particles satellite to continue the line of work of *1961 Upsilon (Explorer XII)*.

• **Soviet astronauts**—During Titov's orbital flight, some changes in the mechanical function of his heart were observed. However, the Soviet scientists reporting on Russian animal and manned flights—V. V. Parin and O. G. Gazenko—would not pinpoint the cause without further analysis of the data.

The scientists said that as the flight continued in the weightless stage, the astronaut experienced motion sickness and nausea, these feelings increasing with any sharp movements of his head.

They interpreted the giddiness and the astronaut's decrease in appetite to the changes occurring in the astronaut's nervous regulatory mechanisms. They also noted that when Titov limited his head movements, the phenomena decreased and almost disappeared.

Commenting on Gagarin's flight, the scientists noted that the experience "did not cause any physiological deviations harmful to the cosmonaut's health and life." The physiological changes taking place during the flight were in the character of adaptation reactions—not too much different from those observed during the astronaut's training in the centrifuge and other devices.

• **Shielding requirements**—The chance of encountering a stream of high-energy protons from the sun is the most serious radiation hazard for a man in a lightly shielded space vehicle or unprotected on the moon. Calculations made by NASA scientist Trutz Foelsche, based on data from November, 1960, solar events, indicate that inside a thin shield of a thickness equivalent to two cm of water, the dose accumulated during an extreme event would be of the order of 1000 rad.

Because of the penetrating characteristics of flare radiations, this "lethal" dose could be reduced to a tolerable one of 25 to 50 rad by a shield thick-

(Continued on page 16)

Titov Says Vostok II Ready to Go Again

SOVIET astronaut Gherman Titov declared last week that his *Vostok II* spacecraft is ready for another flight.

At a crowded news conference in the Soviet Embassy in Washington, the Russian space pilot also commented that he saw some of the same mysterious "fireflies" reported by U.S. astronaut Lt. Col. John H. Glenn after his February orbital trip.

Titov said he saw the phenomenon (which he called "fluorescent sports") twice—once after the last stage of his booster separated, and again when his retrorockets fired.

Titov was in Washington to attend the COSPAR meeting where, like Glenn, he was to deliver a paper.

He and the U.S. astronaut were to tour the Capitol building together, after which Titov was to meet President Kennedy.

Thursday evening, the U.S. and Soviet spacemen were to hold a joint news conference.

At his embassy meeting with the U.S. press, Titov brought up the subject of disarmament.

He said Soviet-American cooperation in space would move forward rapidly when and if there were a disarmament agreement.

He also predicted that men and women from many nations would make flights to the moon and planets.

"A Soviet pilot can land his spaceship in any chosen place," Titov declared at one point.

This claim had been made previously by Russian space officials. But Titov's statement that *Vostok II* was ready for action again was news.



TITOV and wife, Tamara, are welcomed at Washington National Airport by Soviet Ambassador Antoly Dobrynin (left).

by Hal Taylor

NAA Space Lab Unveiled at IAS Meet

Self-erecting concept is also highly regarded for potential as test bed, launch platform; other news from Manned Flight meeting

ST. LOUIS—A self-erecting manned orbiting laboratory may be the next major development project in the U.S. space program.

One of NASA's highest ranking officials told MISSILES AND ROCKETS that a start on the laboratory, which might hold as many as 27 astronauts, could be made within a year or so.

Total development time is estimated at four to six years.

Besides serving as a test bed for space experiments, the spacecraft could be used as an orbiting launch platform for lunar and interplanetary missions. Use as an astronomical observatory and space station for manned military missions are other possible missions.

Support for the project follows hard on the heels of the space agency's scrapping of its plans to build an orbiting laboratory module for the *Apollo* spacecraft.

Instead, NASA plans to build the laboratory as a separate project.

"I think it is a wonderful concept," the official said, "We will need it irrespective of what we find in the space environment."

The official—who has a great deal of authority in NASA spacecraft programs—said that as yet no recommendation for a go-ahead in the program has been made. In the light of his comments, however, the recommendation seemed sure to be forthcoming.

The existence of the project was first disclosed in MISSILES AND ROCKETS on Jan. 1, 1962, p. 11.

The release of detailed engineering plans by North American Aviation, Inc., was one of the highlights of the Institute of the Aerospace Sciences meeting on Manned Space Flight here.

• **Light and compact** — The firm studied the feasibility of the project under a six-month NASA contract. Its report is scheduled to be made to the space agency in the middle of May.

E. A. Weber, NAA's project engineer, told the IAS meeting—attended by over 600 members from 265 firms—that the laboratory would weigh 150,000 lbs. and would be boosted into a low Earth orbit by a two-stage *Advanced Saturn* launch vehicle.

It was designed for a minimum orbital lifetime of one year, but could stay up for two to three years. *Apollo* command and service modules would be used to ferry the crew to the laboratory, using a *Saturn C-1* or *Titan III* launch vehicle.

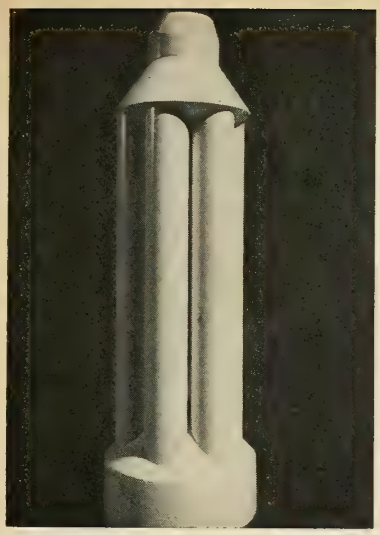
Its advantages, according to Weber, are its compactness and lightweight. In addition, it would be built with present state-of-the-art technology—sharply cutting down development time.

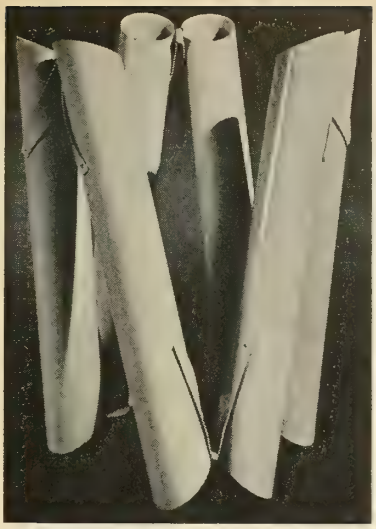
The large multi-manned space station would be composed of six rigid cylindrical sections joined by inflatable sections arranged in a toroidal configuration. Three radial elements of the inflatable structure join the torus to a central non-rotating section. The station is sized so that it can be launched on a single *Advanced Saturn* booster. After the orbit is successfully established, the station is automatically deployed by a

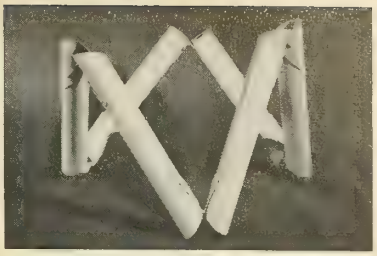


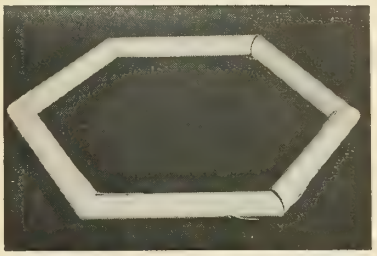
U.S.-U.K. Satellite

ARTIST'S concept of S-51 (Ariel) international ionosphere satellite, now in Earth orbit. It is designed to yield information on solar radiation and primary cosmic radiation.









FIRST PHOTO depicts self-erecting manned orbiting laboratory in its launch position, rigid modules folded with Apollo spacecraft on top. Other pictures show the deployment of the laboratory in space. Sequence does not show final orbital configuration—in which inflatable passageways will connect the modules with the central hub.

system of mechanical actuators between sections.

When fully extended, it is rotated to simulate gravity in the torus.

The 150-ft.-dia. space station would provide a "shirt sleeve" environment for its nominal 21-man crew. Each section, however, will have a life support system capable of sustaining six astronauts, making a total complement of 36 possible. NAA says a crew of 27 should be the maximum on board.

• **Autonomy**—Each module's environment system is independent of the other modules so that a failure in any one module will not result in the loss of the crew members aboard the station. Under current planning the systems will be semi-closed, requiring resupply of oxygen nitrogen and water on a periodical basis.

Each module will also have its own independent power system. A solar cell system is favored by NAA because of its availability and reliability. The firm did not recommend them for later use; it said the reliability of other systems will be established.

A docking facility able to accommodate a maximum of seven *Apollo* vehicles, is included in the space station plans. When the *Apollo* approaches the space station, the docking attachment is driven opposite to the space station rotation. The *Apollo* which was launched with the station is moved to one side. The docking attachment then is permitted to approach the station rotational velocity, and the crew members exit to the hub by means of tubes which are extended to the *Apollo* airlock.

"Since the space station will be the first long-duration manned vehicle to be placed in space, reliability of operation is exceedingly important," Weber said. "As a result, the equipment used must be within today's state of the art."

The IAS meeting was attended by almost all of the leading U.S. civilian and military manned space flight experts. Many of the papers dealing with Project *Apollo* and the Air Force's *Dyna-Soar* program were classified.

Some of the interesting unclassified papers and speeches at the meeting included:

• Col. Langdon F. Ayres of the Air Force Systems Command asserted in a paper on solid-propellant boosters, that there is some doubt about the feasibility of a 260-in. solid rocket motor. He said that most of the problems center in its ignition system, the combination of liquid and solid stages and the transportation of the large boosters. The latter problem will require that the big motor be built either on or near its launch site.

He said that current Air Force planning is proceeding on the assumption that these problems will be solved.

Feasibility of the 156-in. motor is being assumed, Ayres noted. He said this development program will move directly from design to the semi-prototype stage. Again, one problem will be transportation of large segments.

• Gen. Bernard A. Schriever, commander of the AF Systems Command, declared that the *Polaris* and *Minuteman* ICBM's give the U.S. a distinct advantage over the Soviet Union in the field of solid rockets.

Schriever said that he still favors a speed-up in the *Dyna-Soar* program—and this may be possible if the DOD decides to spend $42 million in additional funds which was voted by the House recently.

He also said that he is currently trying to get Pentagon approval for Phase I of the *Titan III* program. This includes, according to informed sources, the award of a contract for the 120-in. solid motor and details of the design and development flight schedule for the Air Force space booster.

• Robert H. Gilruth, Director of the Manned Spacecraft Center at Houston, Tex., said that "the presence of the human crew in spacecraft should lead to design criteria more similar to manned aircraft than to ballistic missile criteria." Since man has now demonstrated his ability to operate in space flight environment, he said, "vehicle design for manned space flight can now consider full utilization of human crew capabilities. This utilization of crews should lead to increased reliability in terms of both flight safety and mission success."

• Elmer M. Morse, Aeronautical Systems Division, AFSC, addressing a spacecraft design session, said that molecular forming is the joining process of the future. He also said that integrating design data into numerically controlled machine tools will eliminate many intermediate steps and improve machined parts in spacecraft construction.

• Francis M. Rogallo of NASA Langley Research Center, designer of a flexible glider for recovery of spacecraft, said use of such devices is "feasible." He said such a system has the packagability of parachutes. ⌗

Five Firms Bidding For Nova Study Awards

Hardware contracts not due until 1963 under new timetable providing for review of Apollo systems integration

INDUSTRIAL development of the *Nova* superbooster will not begin before 1963 at the earliest.

The new timetable for the multi-million-lb.-thrust booster was revealed as NASA announced that five missile/space firms are bidding for two design and study contracts.

The bidders are Douglas Aircraft Co., General Dynamics/Astronautics, Lockheed Aircraft Corp., Martin Marietta Co., and North American Aviation, Inc.

NASA said award of the two parallel six-month contracts will not be made until July. This will put the award of actual hardware contracts off until sometime early next year.

Originally, the space agency announced that the study contractors would be selected this month. It now says the additional time is needed to complete further in-house studies of the *Nova* configuration.

This review, it was learned, is part of the overall systems integration study now being conducted on the entire Project *Apollo* manned lunar landing program.

NASA currently plans a *Nova* booster which will develop 12 million lbs. of thrust in a first stage powered by eight Rocketdyne F-1 engines. The second stage will develop about four million lbs. thrust with four Aerojet-General M-1 engines. A single 200,000-lb.-thrust Rocketdyne J-2 engine will power the third stage.

Fifteen missile/space firms had been asked to submit bids for the study contracts. Firms which did not submit bids included Aerojet-General Corp., Bell Aircraft Co., Boeing Co., Chrysler Corp., Ford Motor Co., Grumman Aircraft Engineering Co., Ling-Temco-Vought, Inc., McDonnell Aircraft Corp., Northrop Corp., and Republic Aviation Corp.

• **A jump ahead**—NASA will commit $700,000 to each of the two firms selected to make the studies. In addition, the firms will spend some of their own funds to complete the contract. This may well prove to be a good investment, because the two firms will be far ahead of their competitors in the race for the two *Nova* industrial development contracts.

The companies selected for the study contracts will:

—Develop a detailed set of criteria and model specifications for the complete *Nova* vehicle, supported by a detailed preliminary design.

—Define a manufacturing plan including fabrication, inspection and test methods, as well as major facility and equipment requirements.

—Determine the method of achieving acceptable reliability at the earliest possible time.

—Define the testing program required.

—Develop a schedule, funding and management plan for the overall *Nova* program.

• **More M-1 money**—NASA plans to spend some $16.2 million of Fiscal 1962 funds for facilities for the M-1 liquid hydrogen engine. The space agency told the Senate Space Committee the funds would be used to build new facilities and modify existing ones at Aerojet-General's plant near Sacramento, Calif.

The space agency said the Fiscal '62 funds must be reprogramed for M-1 use so that arrangements can be made to test the engine in order to finalize the contract with the firm.

Aerojet will finance "non-severable" facilities—those that cannot be moved. NASA plans to finance "severable" facilities—including altitude simulator systems, flame detectors, deflector cooling systems, liquid hydrogen and oxygen systems, handling equipment for existing and new test positions, and cryogenic and special test equipment for a development engineering cryogenic laboratory to be built by Aerojet.

Funds will also be spent for quality control equipment to be installed in a development fabrication facility to be constructed by the company. ⌗

COSPAR Meeting

(Continued from page 13)

ness of 25 cm of water. The speaker considered this amount of shield a "conservative upper limit." However, he warned prospective designers to watch out for the contributions of biologically effective secondaries, whose generation would depend on construction and on the shielding materials.

• **Structure of atmosphere**—In a review paper, V. G. Istomin and A. A. Pokhunkov reported on the results of neutral and ion composition measurements made above 100 km, carried out in the USSR with radiofrequency mass-spectrometers mounted in geophysical rockets and satellites.

The main ionosphere components, based on rocket soundings, were given at NO^+, O_2^+, O^+, N_2^+ and N^+ ions. The first three components were found to have diurnal effects at the 100-210 km height.

Based on satellite data, the main component up to about 1000 km altitude reportedly is ionized atomic oxygen O^+. The Russian scientists also observed that the main components of the neutral atmosphere up to 300-km altitude are molecular nitrogen N_2, atomic oxygen O, and molecular oxygen O_2. At altitudes above 200 km, a large amount of non-dissociated oxygen O_2 was observed, indicating the importance of the diffusion processes.

Gravitational separation of Ar and N_2 gases was also observed, the beginning of the separation occurring at about 110 km.

In another paper, Istomin took up the question of ions of extraterrestrial origin in the Earth's ionosphere. He noted that during rocket soundings of the ionosphere made near 100 km, ions were found whose presence could not be explained by the nitrogen-oxygen model of the Earth's atmosphere. The detected ions were identified at Mg^+, Si^+, Ca^+ and Fe^+. In addition, Mg^+ and Si^+ ions were also found in a thin layer at 120 km. The altitude at which these unexpected ions were detected and their relative ratios indicated a meteor origin.

• **Helium in upper atmosphere**—NASA scientists R. E. Bourdeau and S. J. Bauer reported on the structure of the upper atmosphere determined from charged-particle measurements on rockets and the *Explorer VIII* satellite. Data showed that there are two transition regions—from oxygen to helium ions and from helium to hydrogen ions—in the upper ionosphere, rather than a single transition from oxygen to hydrogen ions as previously believed.

The authors also said that these data

(Continued on page 42)

NASA Tries New Recruiting Tests

by Heather M. David

NASA HAS MOVED to solve its shortage of scientists and engineers.

The solution, according to personnel director Robert Lacklen, is to upgrade the quality of its scientific and creative talent.

Some time ago, therefore, NASA started looking for a tool that would help its hiring offices seek out the applicants with the highest potential of creative ability.

This tool, NASA expected, could ultimately be extended to use at the high school and college levels—so that creative youngsters could be recognized early and encouraged. Some psychologists suspect that many creative students are stifled by the academic process and drop out along the way.

• **False indicators?**—The tools most commonly used in evaluating job applicants—especially those with no experience—are IQ scores and academic achievement.

Prof. Calvin Taylor, head of the psychology department at the University of Utah and a trailblazer in the field of "identifying the creative," said that investigators have found that suggestors of good ideas had approximate IQ scores which were spread out across the entire gamut of such scores.

"Sheer number of years of education is also not a good predictor of creative performance," Taylor adds. Often high school students in summer research programs show more creativity than do teachers working in the same programs.

And, perhaps most startling, Taylor says "Our studies of Air Force and space agency scientists and the research of others on the nature of creative and productive scientific talent suggest that the type of talent needed for successful academic performance (in school-like activities) may not overlap very much the nature of talent required for successful performances in research activities." He adds, "The process of mastering existing knowledge is psychologically different from the process of producing and creating new ideas and new knowledge."

Another method of identifying successful people used in World War II for flying personnel was that of biographical inventories. Do a man's childhood home life, his boyhood hobbies and interests, seem to fit him into a category as a man?

Professor Taylor was engaged by NASA to investigate whether this biographical inventory had any validity. He had already done a good deal of work with the National Science Foundation, which has been the center of efforts to identify creative talent, sponsoring conferences on the subject every other summer. NASA let a two-year $15,000 contract in 1959, and a $40,000 contract in 1961 for another two years.

First, NASA had to determine what kind of people it really wanted. By studying these, perhaps they could learn to recognize others like them by determining what things they had in common.

• **Who is creative?** — Perversely enough, it was no easy task to identify the creative people in NASA so that they could be studied. There were a number of possible criteria—membership in *Who's Who,* number of papers published (a common measure in research organizations and in the academic world), number of patents held, supervisors, evaluations.

Another method, which NASA already used in payroll analysis, is measuring the breadth of application of a man's creative products, rather than measuring the man himself. The personnel office looks at his inventions, papers, solutions and theories, and measures their creativity on a scale.

On this creativity scale, a high-ranking product not only answers the question or problem the scientist started out with, but can be applied to a broad sweep of things.

Those scientists and engineers whose contributions rated high on this scale were rated eligible for a GS grade a notch higher than that for which they would otherwise qualify — a bonus which NASA secured for its members from the Civil Service Commission.

• **Tests given**—The first group to take the biographical inventory was a group of 325 professional people at Lewis Research Center. There were definite patterns in the answers of those who had been evaluated as the most creative.

The questionnaire was reworked and some of the nonsignificant questions eliminated. A group of 200 at Ames was given the form, and the high correlations held up. Just recently a group of some 300 at Langley took the questionnaire, which has again been improved. The correlations continue to be much higher than produced by any other device used to predict creativity.

NASA will give the test to the 1100 college graduates it will hire this June, and do follow-up studies to see whether it really is significant in predicting who will be creative.

The biographical information inventory as it now stands includes 300 questions ranging from "When did you reach physical maturity as compared to others?," and "How many books did you have in your home during your youth?," to "How sensitive are you to criticism in comparison to your associates?"

Although NASA will not say exactly which answers indicate creativity, Lacklen indicated that parent relations and family life apparently had no correlation. Real correlations, he said, appear in answers to questions which indicated the youth's boyhood choices in such matters as hobbies and organizations.

One of the beauties of the biographic inventory as a testing device is that it requires no time limits or supervision by the personnel office. In addition, the applicant experiences no nervousness—there are no "right" answers requiring concentration.

• **Other conclusions**—If the biographical inventory proves as successful as it now appears to be, the benefits may be tremendous. As Prof. Taylor has pointed out, potential research scientists do not begin "practicing" until they finish their education, and may be well into their twenties. If these people can be recognized when very young, they could begin their research experience in high school. He points out that people who desire a career in the fine arts—music or painting would not dream of postponing their actual work until after they were 20 years old.

All research organizations are well aware that the USSR is producing two or three times as many scientific and technical professional graduates yearly as is the United States. Says Taylor: "One of our remaining hopes was that we might be able to rely on one or more types of important high-quality personnel in order to remain in competition over the long pull." ⁂



Problem for Skybolt: Where is this patch of sky?

To calculate its trajectory to target, Skybolt air-launched ballistic missile will have to know precisely where it is at any given moment, day or night. This problem is neatly solved by the star tracking capability of its astro-inertial guidance system, which can provide an instantaneous fix on any piece of sky the mother plane passes through. When Skybolt is operational, the guidance system will put it into a ballistic trajectory after launch, to deliver the warhead on target up to 1000 miles away.

This versatile stellar-monitored inertial guidance system is being developed for the USAF-Douglas Skybolt by the Nortronics Division of Northrop.

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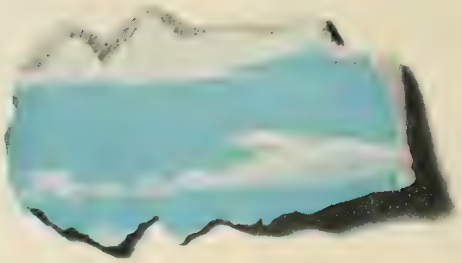
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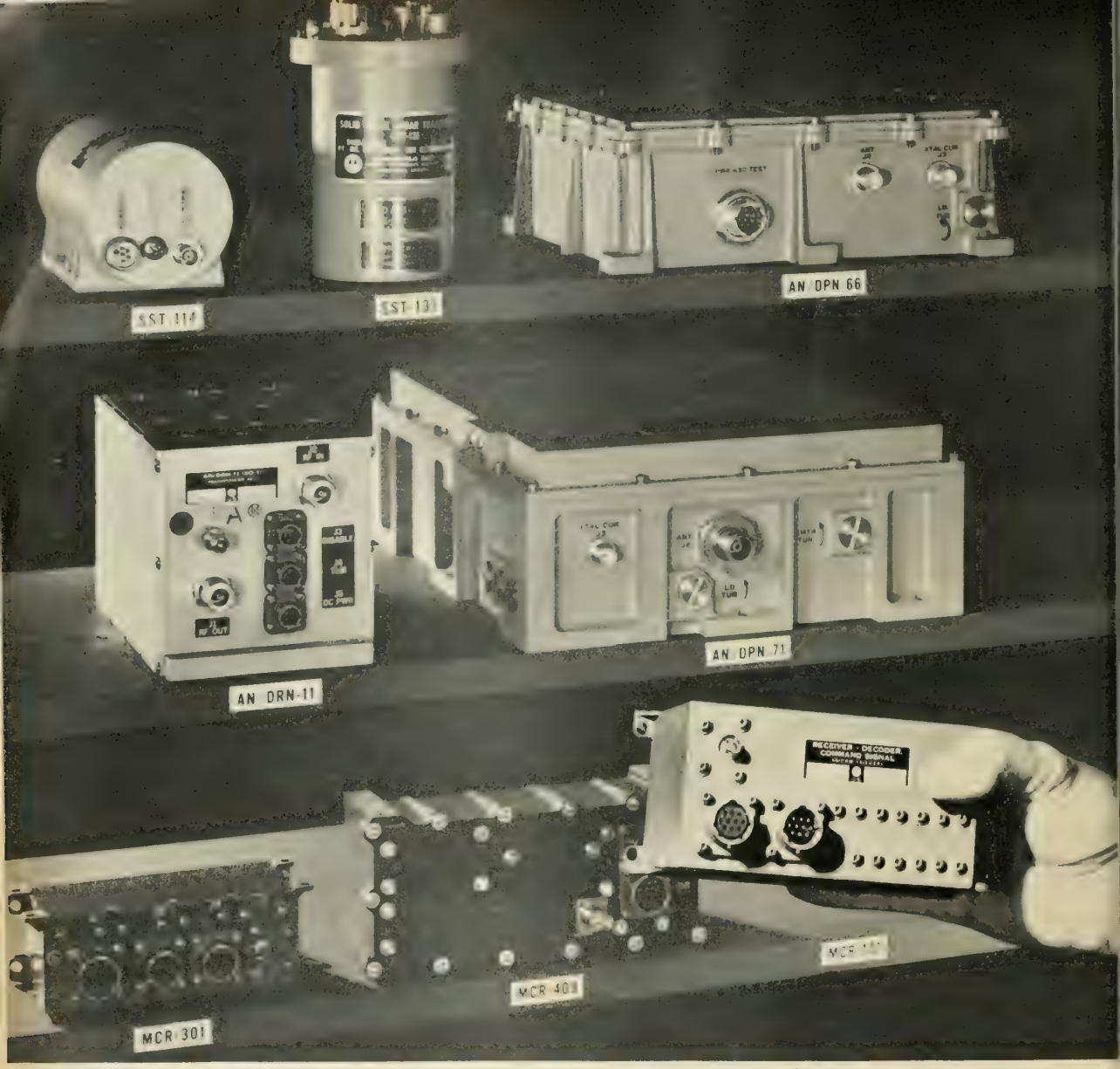
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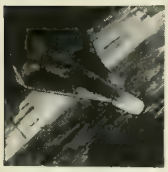
PROJECT	CONTRACTORS	DESCRIPTION	STATUS
ALFA (Navy)	Navy, prime; Avco, air frame	ASW surface-to-underwater; 500 lb. solid; conventional	Operational; deployed on destroyer escorts
★**ASROC** (Navy)	Minneapolis-Honeywell, prime; Sangamo Electric, sonar; torpedo, GE; Librascope-General Precision, fire control	ASW surface-to-underwater; solid nuclear or conventional, range about 8 miles; advanced ASROC (improved Mark 44 torpedo) under R&D	Operational on destroyers, destroyer escorts, heavy cruisers and guided missile frigates.
★**ASTOR** (Navy)	Westinghouse, prime	Mark 45 ASW underwater to underwater wire-guided torpedo; nuclear or conventional	Operational on hunter-killer submarines
★**ATLAS** (Air Force)	GD/Astronautics, prime; GE/Burroughs, Arma, guidance; Rocketdyne, propulsion; GE/Avco, re-entry vehicle; Acoustica, propellant utilization	ICBM; 5500-to-9000 mile range; liquid; nuclear; ATLAS "E" and "F" series have inertial guidance; earlier ATLAS "D" has radio inertial; proposed ATLAS "G" would have 900,000-lb. thrust and 4000-lb. payload capability	Operational; 13 squadrons planned at 4 bases; already emplaced at Vandenberg, Warren, Offutt, Fairchild and Forbes; total of 54 launchers operational, ATLAS F being tested
★**BOMARC** IM-99A (Air Force)	Boeing, prime; IBM/Westinghouse, guidance; Aerojet/Marquardt, propulsion	Ramjet surface-to-air interceptor; liquid booster; 250 m. range; Mach 2.7; nuclear	Five bases operational in Northeastern U.S. from Virginia to Maine, production completed
★**BOMARC** IM-99B (Air Force)	Boeing, prime; Kearfott/Westinghouse, IBM guidance; Thiokol/Marquardt, propulsion	Ramjet, surface-to-air; solid booster; Mach 4; more than 400 m. range; nuclear	First base operational May, 1961; two more planned; A-squadrons will be strengthened with advanced B model
★**BULLPUP** GAM-83, ASM-N-7A (Navy-Air Force)	Martin, prime; Martin, guidance; Thiokol, Naval Propellant Plant, propulsion; Maxson, second-source prime	Air-to-surface; 3-6 mile range; radio-guided conventional 250-1000-lb. bomb; BULLPUP B: nuclear warhead and 1 pre-packaged liquid motor; nuclear-tipped model nearly operational	Deployed with Atlantic and Pacific Fleets; operational with Air Force units. Marines launching BULLPUP from helicopters.
★**CORPORAL** (Army)	Firestone, prime; Gilfillan, guidance; Ryan, propulsion	Surface-to-surface; 75-mile range; liquid; nuclear; command guidance	Deployed with U.S. & NATO troops in Europe. SERGEANT to replace CORPORAL beginning this year
★**DAVY CROCKETT** (Army)	In-house project directed by Rock Island, Ill., arsenal	Surface to surface; solid; bazooka launched; sub-kiloton nuclear warhead; two launchers: vehicle mounted or carried by two men	Operational in Europe; FY '63 budget funds for majority of inventory objective
★**ENTAC** (Army)	Nord Aviation, prime	Antitank; 6600-ft. range; 37 lbs.; HE warhead; wire-guided; man-portable	Operational; Army buying from French in quantity to replace SS-10
★**FABMDS** (Army)	GD/Astronautics, Hughes, Martin, GE, Raytheon, Sylvania—feasibility studies	Mobile antimissile defense system to provide an effective defense of the field army against enemy ballistic missiles	Feasibility studies submitted to ARGMA last year; evaluated by special committees of experts; however, future of program in doubt due to DOD opposition
★**FALCON** GAR-1, 10, 2, 2A, 3, 4, 9, 11 (Air Force)	Hughes, prime; Hughes, guidance; Thiokol, propulsion	Air-to-air; 5-mile range; Mach 2; solid; conventional; GAR-11 model has nuclear warhead	Operational; buy-out of GAR 3A, 4A and 11 in FY '62; GAR 9 under continued development
GENIE MB-1 (Air Force)	Douglas, prime; Aerojet-General, propulsion	Air-to-air unguided; 1.5-mile range nuclear	Operational
★**HAAW** (Army)	AOMC, prime	No details available; Heavy antitank/assault weapon	Development; funds provided in FY '63 budget

★ **Indicates changes since March, 1962, Astrolog**

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
★**HAWK** (Army)	Raytheon, prime; Raytheon, guidance; Aerojet-General, propulsion	Surface-to-air; 22-mile range; solid; conventional; provides defense against medium and low-flying aircraft and cruise-type missiles; improvements in system to be phased into production and furnished as modification kits to existing equipment	Operational; deployed in Europe, Panama, Okinawa, U.S. (13 battalions); '63 procurement will essentially complete deployment objective
★**HONEST JOHN** (Army)	Douglas/Emerson Electric, prime; Hercules, propulsion	Surface-to-surface; unguided; 12-mile range; nuclear; 5800 lbs.; ADVANCED HONEST JOHN has increased performance, lighter and smaller; also developed a lighter-weight mobile launcher and an air-transporter launcher	Operational; deployed in Europe; to be replaced by MISSILE B
★**HOUND DOG** GAM-77 (Air Force)	North American, prime; Autonetics, guidance; Pratt and Whitney, propulsion	Air breathing air-to-surface; standoff missile; 500-mile range; Mach 1.7; turbojet; nuclear; B version in production	Operational; to be launched from B-52G intercontinental bombers; stockpile expected to exceed 400
★**JUPITER** SM-78 (Air Force)	Chrysler, prime; Sperry Farragut, guidance; Rocketdyne, propulsion; Goodyear/CLT, re-entry vehicle	IRBM; liquid; nuclear range: over 1500 mi.; guidance: all-inertial	Operational in Italy (30 launchers) with Italian AF; also deployed in Turkey;
★**LACROSSE** (Army)	Martin, prime; Martin, guidance; Thiokol propulsion	Surface-to-surface; highly mobile; 20-mile range; solid; nuclear	Operational; three units deployed in Europe; total of eight planned; to be replaced by MISSILE B
★**LITTLE JOHN** (Army)	Emerson Electric, prime; Hercules Powder, propulsion	Surface-to-surface; unguided; 10-mile range; solid; nuclear; supplements medium and heavy artillery in airborne divisions and air-transportable commands	Two battalions activated in '61; each equipped with four launchers
★**M72** (Army)	Hesse-Eastern Div., Flightex Fabrics, prime	Light antitank rocket; carrier tube launcher; 4.5 lbs.; 25 in. long/3 in. diameter; range 500 yd.; replaces 3.5 in. rocket launcher and rifle grenade; before type classification system known as LAW	Operational
★**MACE** TM-76 (Air Force)	Martin, prime; Goodyear/AC Spark Plug, guidance; Thiokol/Allison, propulsion	Air-breathing surface-to-surface; more than 650-mile range; turbojet & solid-nuclear; B model has more than 1200 mile range; inertial guidance in MACE B	Being deployed with U.S. troops in West Germany; new all mobile but hard-base version development completed; to be in Okinawa, Korea; replaced MATADOR in U.S. arsenal
MATADOR TM-61C (Air Force)	Martin, prime; Thiokol/Allison, propulsion	Air-breathing surface-to-surface; 500 mile range	Being turned over to West Germans; also deployed in Far East
★**MAULER** (Army)	GD/Pomona, prime; Hughes, guidance; Lockheed, propulsion; DeHaviland, IR acquisition	Surface-to-air; radar guidance; highly mobile antiaircraft and antimissile missile for field use; on tracked vehicle; 12 missiles per launcher	R&D; NATO may buy; program to be accelerated in FY'63
★**MEDIUM-RANGE BALLISTIC MISSILE** (Air Force)	Guidance: AC Spark Plug and GPI competing for contract	Two-stage, solid propellant, stellar-inertial guidance; entire system contained in one mobile vehicle; range: 300-1500 miles	Being restudied at DOD direction; development postponed pending study results; state-of-art missile to be developed in shortest possible time; to be deployed in Europe and Far East
★**MINUTEMAN** SM-80 (Air Force)	Boeing, major contractor; Autonetics, guidance; Thiokol, propulsion first stage; Aerojet, propulsion second stage; Hercules, third stage; Avco, re-entry vehicle	2nd generation ICBM; solid; deployed in hardened and dispersed silos; nuclear; 3 stages; range: over 5000 miles; guidance: all-inertial	Development; initial procurement late this year; scheduled to be operational mid-1962 at Malmstrom AFB; 3 squadrons at Malmstrom, Mont; Ellsworth, S. D.; Whiteman, Mo.; Minot, N. D.; 16 squadrons to be procured through FY '63, more in later years; mobile version killed
M-55 (Army)	Norris Thermador, prime	Four-inch diameter, small, short-range rockets; for delivery of chemical agents; to be fired from 45-tube launchers	Operational
★**MISSILE B** (Army)	AOMC, prime	A highly-mobile general-purpose missile; range 10-50 miles	Funds available in FY '63 budget for initial development; eventually will replace HONEST JOHN and LACROSSE; division support weapon
★**NIKE-AJAX** (Army)	Western Electric, prime; Western Electric, guidance; Thiokol, propulsion; Douglas, airframe	Surface-to-air; 25-mile range; Mach 2.5; solid & liquid; conventional	Deployed in U.S., Europe & Far East; 19 battalions still operated by National Guard are gradually being phased out
★**NIKE-HERCULES** (Army)	Western Electric, prime; Western Electric guidance; Hercules & Thiokol, propulsion; Douglas, airframe	Surface-to-air; 75-mile range; Mach 3+; nuclear; antiaircraft, tactical missiles; mobile or fixed	Rapidly replacing NIKE-AJAX; well over 80 batteries deployed in U.S.; increasing number to be manned by Army National Guard Units; more than 10 N-H batteries were deployed overseas in 1961; N-H on Formosa
★**NIKE-ZEUS** (Army)	Western Electric, prime; Bell Telephone, guidance; Thiokol/Lockheed, propulsion; Douglas, airframe	Anti-missile; 3-stage; 200-mile range; solid; nuclear	R&D test launchings at White Sands, and Pt. Mugu; complete system tests at Kwajalein about middle of year; first ZEUS Kwajalein launching Dec. 14
★**PERSHING** (Army)	Martin, prime; Bendix, guidance, Thiokol, propulsion	Surface-to-surface; two-stage solid; approx. 400-mile range; nuclear; transported on FMC XM474 tracked vehicle; proposed PERSHING II would have 1000-mile range	R&D; to replace REDSTONE. Operational this year in Europe; W. Germany buying PERSHINGS

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
★**POLARIS** (Navy)	Lockheed, prime; GE/MIT, guidance and fire control; Aerojet-General, propulsion; Lockheed, re-entry vehicle	Underwater and surface-to-surface; solid; 1200-mile range; A-1 installed aboard first six submarines; nuclear; A-2 (1500 n.m.) aboard submarines 7-19; A-3 (2500 n.m.) aboard 20th and all subsequent subs; possible A-4 4000-5000 mile range missile under study. Total POLARIS submarine program: 41 with six being added during FY '63 and final six during FY '64	Five subs each with 16 missiles operational. A2 scheduled to be operational in 1962; A3 in 1964
QUAIL (Air Force)	McDonnell, prime; Guidance Technology, Inc. guidance; GE, propulsion; Ramo-Wooldridge, ECM equipment	ECM-carrying bomber decoy; about 200 m. range; turbo jet powered advanced version with 400 mile range has been flight tested	Deployed at SAC bases; carried by B-52; procurement completed FY '61
★**REDEYE** (Army)	GD/Pomona, prime; Philco General Dynamics/Electronics, guidance; Atlantic Research, propulsion	Surface-to-air; 4-foot, 20-lb. bazooka-type; IR guidance; solid; conventional; container-launcher disposable for use against low flying aircraft	Development, plans for immediate production cancelled because of unsatisfactory tests
REDSTONE (Army)	Chrysler, prime; Sperry Farragut, guidance; Rocketdyne, propulsion	Surface-to-surface; liquid; 200-mile range; nuclear	Deployed with U.S. troops in Europe; to be replaced by PERSHING
★**REGULUS I** (Navy)	Chance Vought, prime and guidance; Aerojet-General, propulsion	Surface-to-surface; turbojet & solid; 500-mile range; nuclear	Deployed aboard U.S. submarines and cruisers; KDU-1: drone version; modernization program initiated during FY '61 to retrofit missiles with a new airborne guidance system; retrofit to be completed by end of FY '62
★**SERGEANT** (Army)	Sperry, prime; Sperry, guidance; Thiokol, propulsion	Surface-to-surface; solid; more than 75-mile range; nuclear; inertial guidance employs drag brakes in terminal phase of flight	In production; procurement, except for training missiles, to be completed during FY '63; will replace CORPORAL; deployment in Europe in 1962
★**SHILLELAGH** (Army)	Ford Aeronutronic, prime; Raytheon, fire control	Surface-to-surface; lightweight; can be vehicle-mounted for use against field fortifications, armor and close-in support of troops	Development; technical difficulties may force radical changes in system
★**SHRIKE** (Navy)	NOTS-China Lake, prime; Texas Instruments, guidance	Air-to-surface; anti-radar; formerly called ARM	Development; first production buy in FY '63 budget
★**SIDEWINDER** (Navy-Air Force)	GE-Philco, prime; Philco/GE guidance; Naval Propellant Plant, propulsion	Air-to-air; IR guidance; more than 2 m. range; conventional; new 1-C models to have switchable IR and radar-guided warheads and a new and improved rocket motor	Deployed with Navy and Air Force; all-weather type under development; delivery of 1-C version to start early in this calendar year
★**SKYBOLT** GAM-87 (Air Force)	Douglas, prime; Nortronics, guidance; Aerojet, propulsion; GE, re-entry vehicle	ALBM; more than 100-mile range; solid; nuclear; to be launched from B-52 G and H and British Vulcan bombers	R&D; to be purchased by British; operational 1964; air drops from B-52 and Vulcan bombers successful; first R&D flight last month partially successful
★**SLAM** (Air Force)	No contract announced	Surface-to-surface; low-altitude; supersonic; nuclear ramjet; designed to conduct long aerial patrols at speeds up to 2000 mph.	Propulsion system being developed under project PLUTO; feasibility proven
★**SPARROW III** (Navy)	Raytheon, prime; Raytheon, guidance; Aerojet-General, Thiokol propulsion	Air-to-air; 5-8 mile range; Mach 2.5-3; solid and pre-packaged liquid; conventional	Operational with carrier aircraft, earlier SPARROW I obsolete; production begun on advanced version (SPARROW III B) to be prime armament for F4H-1 interceptor; F3H-2 Demon also to carry III B—presently equipped with SPARROW III and III A
SUBROC (Navy)	Goodyear, prime: Kearfott, guidance; Thiokol, propulsion; Librascope-General Precision, fire control	Underwater or surface-to-underwater anti-submarine missile; 25-30 mile range; solid; nuclear	Operational aboard nuclear-powered attack sub Thresher
SS-10 (Army)	Nord Aviation, prime; GE, U.S. licensee	Surface-to-surface; primarily antitank; 1600-yards range; 33 lbs. solid; wire guided; conventional	Operational with U.S., French and other NATO and Western units; battle-tested in North Africa; U.S. Army replacing it with the ENTAC
SS-11 (Army)	Nord Aviation, prime; GE., U.S. licensee	Surface-to-surface; also helicopter-to-surface; 3800-yard range; 63 lbs; wire guided; conventional	Operational, to be used with airborne units
★**TALOS** (Navy)	Bendix, prime; Bendix, McDonnell, Allegany Ballistics Lab., propulsion; Farnsworth Electric, guidance	Surface-to-air; 65-mile range; solid & ramjet; Mach 2.5; nuclear	Operational aboard cruisers Galveston, Oklahoma City and three heavy crusiers; Long Beach, first nuclear-powered missile cruiser, to be equipped with advanced TALOS
★**TARTAR** (Navy)	GD/Pomona, prime; Raytheon, guidance; Aerojet-General, propulsion	Surface-to-air 10-mile range; Mach 2; 15 feet long & 1 foot in diameter; solid dual-thrust motor; conventional	Operational; installed aboard 6 guided missile destroyers and as backup on heavy cruisers equipped with TALOS; advanced version with greater range and improved performance available in 1962
TERNE (Navy)	Kongsberg Vapenfabrikk, prime; Arma, systems integration	Surface-to-underwater ASW missile; 264 lbs; HE warhead	Navy buying from Norway to equip two destroyer escorts
★**TERRIER** (Navy)	GD/Pomona, prime; GD/Pomona, Sperry guidance; ABL, propulsion	Surface-to-air; 10-mile range; Mach 2.5; 27 feet long; solid conventional; 2 greatly improved versions now becoming operational	Operational aboard one attack carrier (Kitty Hawk), one light cruiser (Springfield) and six guided missile frigates; also used by Marines for beachhead operations

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
THOR SM-75 (Air Force)	Douglas, prime; AC Spark Plug, guidance; Rocketdyne, propulsion; GE re-entry vehicle	Surface-to-surface IRBM; 1500-mile range; liquid; nuclear guidance, all inertial	Operational; 4 bases (60 launchers) set up in England.
★**TITAN** SM-68 (Air Force)	Martin, prime; Bell/Sperry, TITAN I guidance; AC Spark Plug, TITAN II guidance; Aerojet-General, propulsion; Avco, TITAN I re-entry vehicle; GE, TITAN II re-entry vehicle	Surface-to-surface ICBM; 5000-mile range; liquid; 90 feet long; nuclear; TITAN I burns LOX-Kerosene; TITAN II has storable propellants, inertial guidance, bigger payload, greater range, 115 ft. long TITAN II to be used as 2nd stage for TITAN III space booster	8 bases for 12 squadrons planned; TITAN I squadron at Lowry AFB declared operational in April; TITAN II scheduled operational early 1963; TITAN I successfully launched from TITAN II silo; first TITAN II test in March successful!
★**TOW** (Army)	Feasibility studies awarded to Martin, McDonnell and Hughes	Tube-launched, optically tracked, wire guided, HE warhead	Follow-on to ENTAC
★**TYPHON** (Navy)	Bendix, missile; Westinghouse, shipboard control	Medium and long range seagoing anti-aircraft and antimissile missiles with offensive capability against surface ships and shore targets; formerly called SUPER TARTAR and SUPER TALOS; solid booster and ramjet sustainer; conventional; supersonic	Development; successor for TALOS, TARTAR and TERRIER; expense of system may delay deployment
WAGTAIL (Air Force)	Minneapolis-Honeywell, prime	Family of airborne RLM's (rear-launched missiles): air-to-air and air-to-surface	Development
ZUNI (Navy)	Naval Ordnance Test Station, prime; Hunter-Douglas, propulsion	Air-to-air, air-to-surface; solid; unguided; 5-m. range; conventional	Operational



Satellites and Spacecraft

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
★**ADVENT** (Army)	Army Signal Corps, prime; Bendix prime for 24-hour satellite communications package; GE, vehicle	Twenty-four hour instantaneous repeater communications satellite; more than 1250 lbs.; program incorporates Projects STEER, DECREE and COURIER; initial launchings into 5000 mile orbits will use ATLAS AGENA B	R&D; ground sites nearing completion at Ft. Dix, N.J., and Camp Roberts, Calif.; shipboard terminals also being designed; program being re-oriented because of technical difficulties
★**ANNA** (Army, Navy, AF, NASA)	No contractors announced	Geodetic satellite; 50-100 lbs.; probably spherical; mission: intercontinental surveying using bright flashing light for triangulation	R&D
AEROS (NASA)	No contract announced	24-hour weather satellite earth-stabilized; TV cameras with variable focus; may use SNAP-50 for power	Planning. First flights would be in 1964 or 1965; unfunded FY '62 budget; TV camera R&D to begin soon.
★**APOLLO** (NASA)	North American, Command & Mission Modules, systems integration; MIT, guidance development; tele-communications, Collins Radio; Stabilization & Control, Minneapolis-Honeywell; Environmental control, AiResearch; Parachute Recovery, Radioplane; Escape Tower Rocket, Lockheed Propulsion Co.	Three-man spacecraft for earth orbital, lunar orbital and lunar landing missions. Boosters: Advanced SATURN (C-5) for rendezvous; NOVA for direct flight	Earth orbital shots scheduled 1964-65; lunar orbits 1966; lunar landing, 1967-68. Propulsion and orbiting lab module contracts due before mid-62
★**ARENTS** (ARPA)	GD/Astronautics, prime	Satellites to investigate space environment at 22,000-m. and to test long-term behavior of components at this altitude; ATLAS-CENTAUR booster	Contract let to build three payloads; launchings aboard a NASA payload table re-evaluated due to CENTAUR decoy.
★**ASP** (Air Force)	No contracts announced	Aerospace plane, a manned spacecraft capable of operating in the atmosphere and space.	Component development program included in FY '63 budget.
★**BAMBI** (ARPA)	GD/Astronautics, STL	Satellite system capable of intercepting enemy missiles in boost phase using space based platforms and interceptors	Feasibility still unproved; additional research underway
★**DISCOVERER** (Air Force)	Lockheed, prime; GE, re-entry vehicle	THOR-AGENA and ATLAS-AGENA launchings of early stabilized satellites; main purpose is to test techniques and components for military space systems	Program life extended; all data on launchings classified as part of New DOD information policy; testing of AGENA D assigned to DISCOVERER program
★**DYNA-SOAR I** (Air Force)	Boeing, spacecraft and systems integrator; Martin, propulsion; Minneapolis-Honeywell, guidance; RCA, communications data link	Boost-glide orbital spacecraft; follow-on to X-15 program; program will demonstrate the capability for positive controlled re-entry and recovery from orbit. TITAN III booster	R&D; program reoriented and suborbital flights eliminated, design details finalized during 1961; Project ASSET will test structural integrity, using BLUE SCOUT
★**ECHO** (NASA)	Langley Research Center, prime	ECHO I: 100 ft. inflatable sphere in 1000 mile orbit; passive communication satellite.	ECHO I in orbit since Aug. 12, 1960; ECHO II January 1962, failed to orbit; sub-orbital tests in '62
★**GEMINI** (NASA)	McDonnell prime; Rocketdyne, Propulsion	Bigger and heavier MERCURY capsule; to carry two men for periods up to two weeks, TITAN II to be used as booster	Development; will be used to determine feasibility of rendezvous for lunar mission; also to test men and components for APOLLO; first unmanned flights, 1963; manned and rendezvous flights, 1964-65

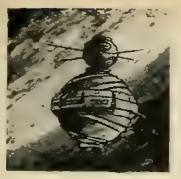
PROJECT	CONTRACTORS	DESCRIPTION	STATUS
MARINER (NASA)	JPL, prime	450 lbs unmanned spacecraft for early interplanetary missions to vicinity of Mars and Venus; boosted by ATLAS-AGENA B	Seven shots planned. First scheduled Venus fly-by Aug. 1962
★**MERCURY** (NASA)	McDonnell, capsule	First U.S. manned satellite; 4000 lbs. + (capsule including escape rocket); boosters: ATLAS and REDSTONE	First manned orbital flight Feb. 20, 1962 by Lt. Col. John Glenn, USMC. 2nd manned orbital flight scheduled for Mid-May, extended (24 hr) flights planned early next year with modified MERCURY capsule
★**MIDAS** (Air Force)	Lockheed, prime; Aerojet IR detector system	Early-warning satellite; detect ICBM launchings by IR; R&D models weigh 2.5 tons; operational system 12-15 satellites	R&D; second launching May 24, 1960 partial success; no launchings of MIDAS during FY '61; two DISCOVERER satellites launched July 12 and Oct. 21 were used for testing MIDAS IR detection equipment in space; all program data classified by DOD direction
★**NIMBUS** (NASA)	Goddard Space Flight Center Prime; GE, integration and testing	2nd generation weather satellite; earth-stabilized polar orbiting; 650 lbs.; TV cameras and IR scanners in payload; THOR-AGENA B booster	First launching scheduled in FY'63; four R&D satellites presently planned
★**OAO** (NASA)	Grumman, prime; Westinghouse, electronic components; GE, stabilization and control	3500-lb. orbiting astronomical satellite observatory equipped with two large telescopes; boosted by SATURN C-1	First flight scheduled in late 1963 or 1964
OGO (NASA)	Space Technology Laboratories, prime	1000-lb. satellites with instruments for geophysical measurements: polar (POGO) and eccentric (EGO) shots planned; ATLAS-AGENA B, THOR-AGENA B, CENTAUR boosters	First flight scheduled in 1963; 19 experiments planned for first shot
OSO (NASA)	Ball Brothers, prime	440-lb. orbiting solar observatory; THOR-DELTA booster, S-16 early version; S-17 and S-57 advanced versions	First flight March 7, 1962; highly successful; first flight for S-17 planned for 1962
★**PROSPECTOR** (NASA)	No contract announced	Soft-landed, remote control, unmanned moon exploring or manned-lunar support spacecraft; SATURN booster	Early design phases; mission will essentially be determined by requirements of APOLLO program; Congress may not approve funding
★**RANGER** (NASA)	JPL, prime; Aeronutronic, capsule; Hercules, retrorocket	300-lb. instrumental capsule rough landed on moon; ATLAS-AGENA B booster	R&D; first two flights RANGERS failed to launch from orbit; RANGER III launched Jan. 26; failed to impact moon, went into solar orbit; RANGER IV impacted on moon April 26; nine RANGERS planned
REBOUND (NASA)	No contract announced	System of 3 to 6 multi-launched passive communications satellites; follow-on to ECHO	First orbital flight scheduled for 1963 or 1964
RELAY (NASA)	RCA, prime	100-lb active repeater experimental communications satellites. DELTA booster	Britain, France, Brazil and Germany building ground stations; first launching this year
★**SATELLITE INTERCEPTOR** (Air Force)	RCA, prime	Anti-satellite inspection system; to be complemented by interception system; about 2 tons; ATLAS-AGENA B launched	R&D; formerly known as SAINT; during March, 1961, contracts let to design, fabricate and test the spacecraft
SAMOS (Air Force)	Lockheed, prime	Reconnaissance satellite; formerly SENTRY; R&D model weighs 4100 lbs.	R&D; SAMOS II successfully launched Jan. 31 from Vandenberg; scheduled to be operational late 1962; advanced SAMOS under development; SAMOS III launching failed Sept. 9; satellite believed to be SAMOS IV launched Nov. 22; all program information classified by DOD direction
SERT (NASA)	RCA, prime	Spinning satellite carrying two electric-propulsion engines for environmental tests	SERT I to be launched last quarter 1962 with Hughes and Lewis Center engines
SLOMAR (Air Force)	Lockheed and Martin, study contracts	Logistics, maintenance, supply spacecraft for space systems	Study contracts awarded in Dec., 1960
SURVEYOR (NASA)	Hughes, prime	750-lb. spacecraft soft-landing 100-300 lbs. instruments on moon; ATLAS-CENTAUR booster also moon orbiting vehicle planned	First moon flights 1964; seven or more to be launched by 1965
★**SYNCOM** (NASA)	Hughes, prime	24-hr. instantaneous repeater communications satellite. DELTA booster; 16-55. lb. satellite; initial inclination to be 30 degrees	R&D; first launching scheduled late 1962
★**TELSTAR** (AT&T-NASA)	BTL, management for AT&T	125 lb., active repeater, experimental industry communication satellite; DELTA booster. To be launched into 3000 mile orbit	R&D; two to four satellites planned for launch in 1962; first launching scheduled in May-June by NASA on cost-reimbursed basis
TIROS (NASA-Wea. Bu.)	RCA, prime	Meteorological satellite; TV pictures of cloud cover; TIROS II and III carried IR scanner	R&D; first launching April, 1960; second Nov. 23, 1960; third last July 12, fourth Feb. 8, all successful; four more planned. TIROS V scheduled for June launch
★**TRANSIT** (Navy)	Applied Physics Laboratory, prime	Navigational satellite; R&D model weighs more than 250 lbs.; operational model about 50-100 lbs. THOR-ABLE-STAR booster	4-satellite operational system scheduled to be in orbit by last quarter 1962 to initially be used by POLARIS subs and greatly reduce the position errors of these subs.

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
★**VOYAGER** (NASA)	JPL	Unmanned MARINER follow-on spacecraft to orbit Mars or Venus; eject several hundred pound TV capsule for planetary entry; SATURN booster; weight approx. 2400 lbs.	Study; first flight planned by 1965
★**X-15** (NASA-AF-Navy)	North American, prime; Thiokol, propulsion	Rocket plane; 4000 mph; flight at edge of space; on AF model each XLR-11 rocket engine develops 16,000 lbs. of thrust; XLR-99 engines 50,000 lbs. Three planes delivered; role expanded to include testing of spacecraft components and space research.	Powered flights in progress; plane #1 has hit Mach 3 and more than 136,500 ft. with XLR-11 engine; plane #2 with XLR-99 engine turned over to NASA; has hit 4093 mph speed record; altitude record of 246,700 ft. (unofficial for manned, powered flight); future flights to 250,000 ft.



Space Vehicles

★**ADVANCED SATURN** (C-5) (NASA)	S-IB, Boeing; S-II, North American; S-IV B, Douglas; F-1, North American; J-2, Pratt & Whitney	S-1B: 5 F-1 engines; S-II; 5 J-2 engines; S-IVB: J-2 engine; 1st stage: LOX/RP; Upper Stages LOX/H_2; 100 ton payload in 345 miles orbit; 43 tons to escape velocity.	R&D; first flight scheduled for 1965 booster planned for APOLLO missions, if rendezvous scheme is successful.
★**AGENA** (Air Force)	Lockheed, prime; Bell, propulsion	1700-pound upper stage designed to go into orbit with payload; 16,000 lbs. thrust after burnout; AGENA B has re-start capability. AGENA D to be developed as a standardized upper stage for TITAN III.	Used in DISCOVERER, SAMOS and MIDAS programs; AGENA B used with ATLAS and THOR
BLUE SCOUT (Air Force)	Aeronutronic, prime; Minneapolis-Honeywell, guidance; Aerojet/Hercules, Thiokol propulsion	Solid multi-stage booster based on NASA's SCOUT rocket; used as sounding rocket and launching small satellite payloads.	Operational
★**CENTAUR** (NASA)	GD/Astronautics, prime; Pratt & Whitney, propulsion; Minneapolis-Honeywell, guidance	High energy upper stage using a pair of LOX-liquid hydrogen engines; 30,000 lbs. total thrust, atop ATLAS booster, capable orbiting 8500 lbs. launching 1450-lb. space probe.	Development; first flight test scheduled last month; technical difficulties postponed it until early May
DELTA (NASA)	Douglas, booster; Bell, guidance; Rocketdyne/Aerojet/ABL, propulsion	Successor to THOR-ABLE; upper stage guidance; 500 lb. payload capacity.	Interim launch vehicle for TIROS-ECHO; being used for other satellites and one deep space probe; 26 previously on order augmented by AF order for 12 more for NASA
★**NOVA** (NASA)	No prime announced; Rocketdyne, 1st stage engine; Aerojet, 2nd stage engine; Rocketdyne, 3rd stage engine	1st Stage: 8 F-1 engines; 2nd Stage: 4 M-1 engines; 3rd Stage: 1 J-2 engine; Payloads: 175 tons in 345 mile orbit; 75 tons to escape; 50 tons planetary probe (liquid)	R&D on 1.5 million lb. F-1 engines; vehicle contracts expected to be awarded this year; solid 1st stage may be developed later; alternative to advanced SATURN (Rendezvous) and ROVER nuclear rocket
ORION (Air Force)	General Atomic	Space booster launched by series of atomic explosions	Advanced engineering studies under way; tests may be attempted with resumption of nuclear testing
★**ROVER** (NASA, AEC)	Aerojet, NERVA prime, Westinghouse, propulsion	First nuclear rocket: KIWI non-flying test engines and NERVA flight engines	First NERVA test flight expected 1966-67
★**SATURN C-1** (NASA)	Marshall Center, S-1 stage, Chrysler Corp.; S-IV, Douglas	2-stage vehicle for early orbital tests of APOLLO and various space programs; 1st stage: LOX/RP; 2nd stage: LOX/H_2; 20,000 lbs into 345 miles earth orbit	First C-1 launching Oct. 27, '61 from Cape successful; second Apr. 24, '62; both flights with inert upper stage; first flight with live upper stages 1963; second stage to be launched in 1963
SCOUT (NASA)	Chance Vought prime; Minneapolis-Honeywell, guidance; Aerojet-General/Heicules/Thiokol/ABL, propulsion	Solid four-stage satellite launcher; 150 lb. payload in 300 n.m. orbit; also, used as sounding rocket	SCOUT flights in '61 completed R&D; Navy proposing SEASCOUT for seaborne surface launch
THOR-ABLE-STAR (Air Force-NASA)	STL, prime; Rocketdyne/Aerojet-General/ABL, propulsion	Three-stage vehicle, orbital capability 800 lbs. Upper stage has restart engines	THOR-ABLE phased out. Used in TRANSIT, COMPOSITE and COURIER
TITAN III (Air Force)	Martin, TITAN II vehicle; Aerojet, liquid engines; Lockheed, standardized upper stage.	Quick reaction vehicle for military space missions; will be used to boost DYNA-SOAR; 1st stage, 2 120-in. solid motors; 2nd stage, TITAN II (storable propellants); 3rd stage, standardized vehicle, probably AGENA D.	Expected to be approved for development soon and the contract for the solid motors awarded early this month; first flights mid or late 1963.



Satellites in Orbit

★**EXPLORER I** (30.8 lbs.) U.S. Launched 1/31/58, est. life 7-10 years. Orbits earth; perigee 353 km, apogee 1731 km, period 105.9 min. (Discovered Van Allen Belt); not transmitting.

★**VANGUARD I** (3.25 lbs.) U.S. Launched 3/17/58, est. life 200-1000 years. Orbits earth; perigee 643 km, apogee 3945 km, period 133.8; transmitting.

LUNIK I "MECHTA" (3245 lbs.) Russia. Launched 1/2/59. In orbit around sun on 450 day cycle; not transmitting.

★**VANGUARD II** (20.7 lbs.) U.S. Launched 2/17/59, est. life 100-250 years. Orbits earth but is "wobbling"; perigee 568 km, apogee 3284 km, period 125.4; not transmitting.

PIONEER IV (13.4 lbs.) U.S. Launched 3/3/59. Orbits sun on 398 day cycle, and achieved primary mission—earth-moon trajectory; not transmitting.

★**VANGUARD III** (about 100 lbs.) U.S. Launched 9/18/59, est. life 50-150 years. Orbits earth; perigee 487 km, apogee 3754 km, period 129.8; not transmitting.

★**EXPLORER VII** (91.5 lbs.) U.S. Launched 10/13/59, est. life 30-40 years. Orbits earth; perigee 559 km, apogee 1070 km, period 101.1; not transmitting.

PIONEER V (94.8 lbs.) U.S. Launched 3/11/60, est. life forever. Orbits sun, interplanetary environment probe; completed one full orbit 1/16/61; aphelion .9951 au, perihelion .8061 au, not transmitting.

★**TIROS I** (270 lbs.) U.S. launched 4/1/60, est. life 50-150 years. Orbits earth; picture-taking weather satellite; perigee 696 km, apogee 746 km, period 99.1; transmitting.

★**TRANSIT IB** (265 lbs.) U.S. Launched 4/13/60, est. life 6 years. Orbits earth; perigee 359 km, apogee 648 km, period 94.6 km. First R&D navigation satellite. Not transmitting.

★**SPUTNIK IV** (10,008 lbs.) Russia. Launched 5/15/60, est. life 2-3 years. Orbits earth; perigee 259 km; apogee 387 km; period 91.0. Test of support systems, cabin, for manned space flight; attempt to return from orbit failed; payload, case and two pieces now in orbit. Not transmitting.

★**MIDAS II** (5000 lbs.) U.S. Launched 5/24/60, est. life 8-15 years. Orbits earth; perigee 473 km, apogee 506 km, period 94.2. Telemetry for IR scanning failed two days after launch. Not transmitting.

TRANSIT II-A (223 lbs.) U.S. Launched 6/22/60, est. life 50-200 years. Orbits earth, perigee 622 km, apogee 1049 km, period 101.6. Transmitting.

★**NRL SOLAR RADIATION SATELLITE I** (40 lbs.) U.S. Launched 6/22/60 with TRANSIT II-A, est. life 50-200 years. Orbits earth; perigee 622 km, apogee 1047 km, period 101.6. Not transmitting.

★**ECHO I** (132 lbs.) U.S. Launched 8/12/60, est. life 2-16 years. Orbits earth; perigee 1261 km, apogee 1767 km, period 116.2. First successful orbiting of passive communication satellite.

★**COURIER IB** (500 lbs.) U.S. Launched 10/4/60, est. life 200-500 years. Orbits earth; perigee 962 km, apogee 1216 km, period 106.8. First successful launching of delayed active repeater satellite. Transmitting.

EXPLORER VIII (90 lbs.) U.S. Launched 11/3/60 by JUNO II, est. life 20-50 years. Orbits earth; perigee 413 km, apogee 2272 km, period 112.4. Provides ionospheric measurements for communications. Not transmitting.

★**TIROS II** (280 lbs.) U.S. Launched 11/23/60, est. life 200-500 years. Orbits earth; perigee 619 km, apogee 731 km, period 98.2. Not transmitting.

SAMOS II (4100 lbs.) U.S. Launched 1/31/61. Orbits earth; perigee 472 km, apogee 548 km, period 94.9. First R&D reconnaissance satellite.

VENUS PROBE (1419 lbs.) Russia. Launched 2/12/61, orbits sun on 300 day cycle; aphelion 1.0190 au, perihelion 0.7183 au.

★**EXPLORER IX** (15 lbs.) U.S. Launched 2/16/61. Orbits earth; perigee 764 km, apogee 2427 km, period 118.0. A 12-ft. "polka dot" balloon.

★**DISCOVERER XX** (2450 lbs.) U.S. Launched 2/17/61. Orbits earth; perigee 272 km, apogee 484 km, period 92.2. No attempt to recover 300-lb. capsule because of malfunction.

★**DISCOVERER XXI** (2100 lbs.) U.S. Launched 2/18/61. Orbits earth; perigee 218 km, apogee 412 km, period 90.9. Carried IR equipment for MIDAS program to measure background radiation from earth.

EXPLORER X (78 lbs.) U.S. Launched 3/25/61. Optical pumping magnetometer. Position uncertain.

★**DISCOVERER XXIII** (2100 lbs.) U.S. Launched 4/8/61. Orbits earth; perigee 243 km, apogee 318 km, period 90.2. Capsule ejected in wrong direction, sending it further into space. Not transmitting.

★**EXPLORER XI** (82 lbs.) U.S. Launched 4/27/61. Orbits earth, perigee 487 km, apogee 1785 km, period 107.9. Measures gamma rays from the stars absorbed in earth's atmosphere.

★**TRANSIT IVA** (IVA, 175 lbs., GREB III, 55 lbs.; INJUN 40 lbs.) U.S. Launched 6/29/61. Orbits earth; TRANSIT—perigee 994 km, apogee 884 km, period 103.8. GREB-INJUN—perigee 883 km, apogee 996 km, period 103.8. Transmitting. GREB III and INJUN failed to separate after three-in-one launch.

TIROS III (285 lbs.) U.S. Launched 7/12/61. Orbits earth; perigee 737 km, apogee 819 km, period 100.3. Transmitting cloud cover weather pictures.

★★**MIDAS III** (3500 lbs.) U.S. Launched 7/12/61. Orbits earth; perigee 3352 km, apogee 3538 km, period 161.5. IR early warning satellite.

★**EXPLORER XII** (83 lbs.) U.S. Launched 8/16/61. Orbits earth, perigee 796 km, apogee 76,715 km, period 1589.7. Study Van Allen belts and energetic particles in space.

MIDAS IV (3500 lbs.) U.S. Launched 10/21/61. Orbits earth; perigee 3532 km, apogee 3720 km, period 166.0. IR scanning early-warning satellite. Transmitting.

★**DISCOVERER XXXIV** (2100 lbs.) U.S. Launched 11/5/61. Orbits earth; perigee 228 km, apogee 848 km, period 95.5. Malfunction in orbit forced abandonment of usual attempt to recover capsule.

★**TRANSIT IVB** (200 lbs.) U.S. Launched 11/15/61. Orbits earth; perigee 952 km, apogee 1110 km, period 105.6. Satellite is an operational prototype of the Navy's navigational satellite. Transmitting.

★**TRAAC** (200 lbs) U.S. Launched 11/15/61 piggy-back on TRANSIT IVB. Orbits earth; perigee, 956 km, apogee 1108 km, period 105.6. Designed to test new system of stabilization based on the earth's gravitational field. Also designed to supply data on the Van Allen belt. Stabilization test still in doubt. Transmitting.

★**RANGER III** (727 lbs.) U.S. Launched 1/26/62. Orbits sun on 406.4 day cycle; probe failed to impact, went into heliocentric orbit; aphelion 1.163 au, perihelion, 0.9839 au. Not transmitting.

★**TIROS IV** (285 lbs.) U.S. Launched 2/8/62. Orbits earth; apogee 838 km, perigee 715 km, period 100.3; weather satellite transmitting cloud cover pictures and IR heat balance data.

★**ORBITING SOLAR OBSERVATORY** (440 lbs.) U.S. Launched 3/7/62. Orbits earth; perigee 559 km, apogee 583 km, period 95.9; payload consisted of 13 experiments to study solar radiations, investigate dust particles in space and thermal radiation characteristics of spacecraft surface materials. Transmitting.

★**COSMOS I** (?) Russia. Launched 3/16/62. Orbits earth; perigee 212 km, apogee 872 km, period 95.4; first of an announced series of satellites to study the space environment and its effect on spacecraft materials; whether satellite is transmitting is not known.

COSMOS II (?) Russia. Launched 4/6/62. Orbits earth; perigee 212.8 km, apogee 1560 km, period 102.5; second in a series of space environmental research satellties; transmission data not known.

★**COSMOS III** Russia. Launched 4/24/62. Orbits earth; perigee 227.2 km, apogee 715.2 km, period 93.8; third of a series and intended to study weather, communications and effects of radiation on man during prolonged space flights.

★**UNIDENTIFIED SATELLITES** U.S. Five payloads launched: 2/21/62 (THOR-AGENA B), March 7 (ATLAS-AGENA B), April 9 (ATLAS-AGENA B) and April 17 (THOR-AGENA B), April 26 (BLUE SCOUT) April 26 (ATLAS-AGENA B); no data available on orbit or even whether satellites achieved orbit in line with new DOD news blackout; presumably all but the BLUE SCOUT payload were Discoverer, Midas or Samos satellites.

S-51 INTERNATIONAL SATELLITE (132 lbs.) U.S.-U.K. Launched 4/26/62; perigee 320 km.; apogee 960 km; first joint satellite (U.K. built payload; U.S. supplied booster, satellite structure and tracking facilities) to study the ionosphere and the intensity of cosmic radiation. Transmitting.

(Orbital data is latest official information as of 1200 Z, March 27, 1962)

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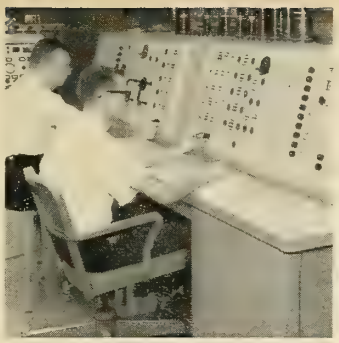
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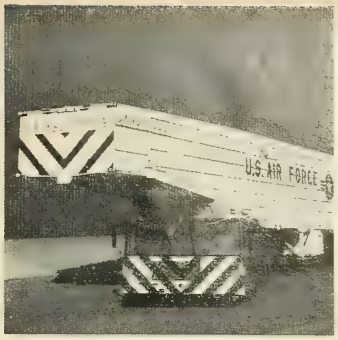
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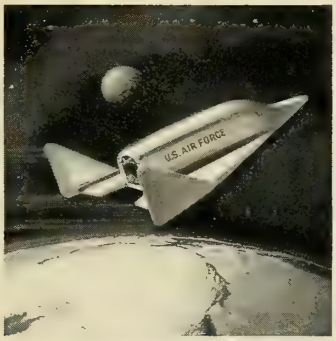
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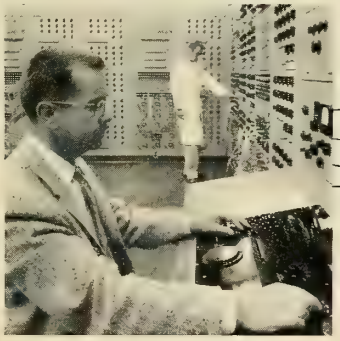
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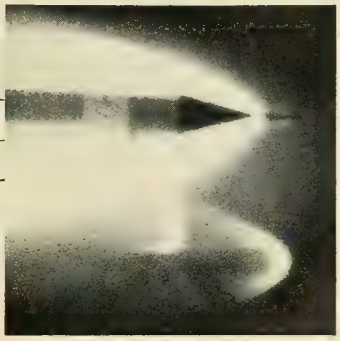
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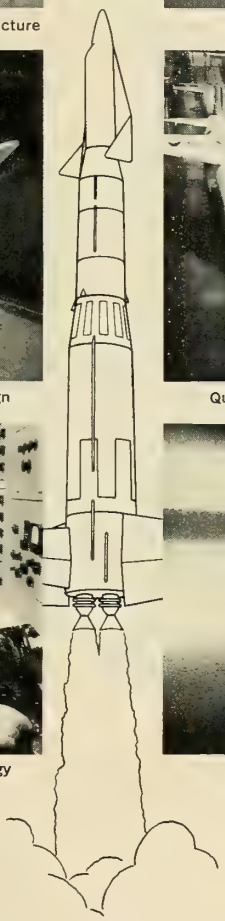
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Supersonic aerodynamics



System-wide capabilities—at Boeing Aero-Space Division

A pioneer in weapon system management, Boeing has capabilities embracing all areas of systems management and aero-space technology.

The Boeing Aero-Space Division includes more than 15,000 engineers, scientists, technicians, manufacturing and staff specialists. They provide the full span of technological and management capabilities required to handle the Division's present and future systems programs.

The Division maintains research and development projects to assure continuing advances in scientific knowledge, as well as in business systems and management methods. On-time delivery is one of the many benefits of the Division's advanced programming and control techniques.

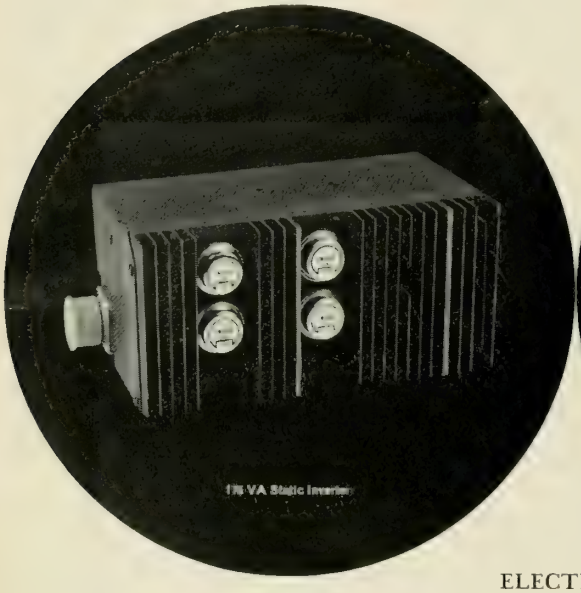
Emphasis on quality control and reliability engineering has contributed toward the Division's outstanding record of performance in systems management. It has also assured the design and development of superior products, manufactured and delivered on schedule, at lowest cost.

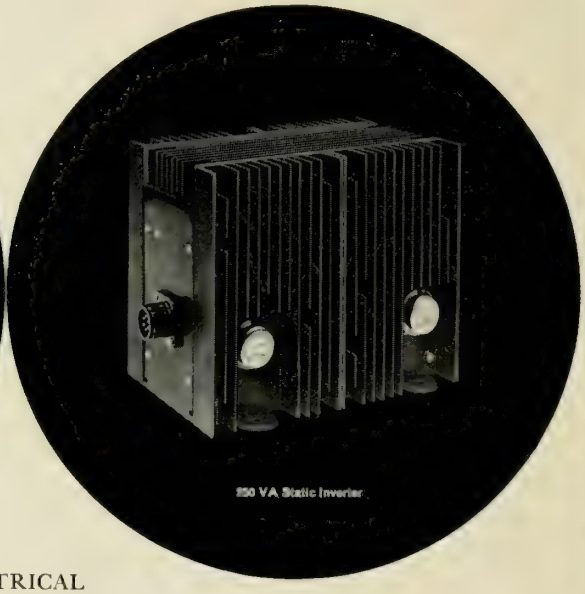
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AERO-SPACE DIVISION

PRECISION WITH SIMPLICITY
FROM DELCO RADIO

That's the big feature in Delco Radio's new 175 VA and 250 VA static inverter power supplies. These *all-transistor* units offer increased reliability through simplified circuits. Both static inverters are designed for either airborne or ground applications and will withstand overload and output short circuit conditions indefinitely, delivering at least 110% of rated output before going into overload protection. Units automatically recover to full output upon removal of overload and short circuit. Units are designed to meet the environmental requirements of MIL-E-5272C. For further information on military electronics write Delco Radio's Military Sales Department.





ELECTRICAL SPECIFICATIONS

175 VA STATIC INVERTER

Input
Voltage: 27.5 VDC ± 10% per MIL-STD-704

Output

Power:	175 VA single phase 0.5 lag to 1.0 power factor
Voltage:	115 V adjustable from 110 to 120 volts
Regulation:	1-volt change for any variation of load between zero and 110% of full load, and input voltage between 25 VDC and 30 VDC
Frequency:	400 ± 1 cps. Frequency changes less than 1.0 cps. for all environment, load and input voltage variation
Distortion:	Less than 5% total harmonic
Efficiency:	80% at full load

250 VA STATIC INVERTER

Input
Voltage: 27.5 VDC ± 10% per MIL-STD-704

Output

Power:	250 VA single phase 0.6 lag to 1.0 power factor
Voltage:	115 V adjustable from 110 to 120 volts
Regulation:	0.7 volt for any variation of load between zero and 110% of full load, and input voltage between 25 VDC and 30 VDC
Frequency:	400 ± .5 cps. Frequency changes less than 1.0 cps. for all environment, load and input voltage variation
Distortion:	Less than 5% total harmonic
Efficiency:	80% at full load

DELCO RADIO
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Technical Countdown

ELECTRONICS

New Gemini Subs Named

Gemini guidance system integration will be directed by IBM's Federal Systems Division in Owego, N. Y. IBM also will be responsible for overall inertial guidance system performance and for development of the advanced guidance computer and manual data insertion unit. In announcing its selection by the McDonnell Aircraft Corp., *Gemini* prime contractor, IBM indicated that Minneapolis-Honeywell had been chosen to build the inertial platform for the system. Systems integration will include all related sensors and control electronics, the company said.

AF Buys Big Guidance Test Facility

With the ultimate goal of significantly reducing checkout

ADVANCED MATERIALS

Lithium-Doped Quartz Grown Rapidly

High-quality synthetic quartz crystals are being grown by Bell Telephone Labs scientists from hydrothermal solutions with added lithium salts. The new crystals have virtually the same acoustical qualities as natural Brazilian quartz and can be used in frequency control resonators and other applications requiring high acoustical quality. Rapidly grown synthetic crystals have been adequate for most oscillator and filter crystal units produced in the U.S., but did not have the high acoustical quality needed for certain applications until the lithium doping process was included.

Crack Immunity Built Into Rubber Molecules

B. F. Goodrich scientists have succeeded in giving rub-

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developers. Used in the recent *Ranger IV* lunar-impact attempt, the lightweight system proved to be one of the few successes in that shot. Volume has been cut from 3¼ cu. ft. to ¾ cu. ft. by transistorizing all electronic units.

a cheap method of determining the existence of life on other planets. An unmanned instrument package would bring the die in contact with local ground samples, match the color and radio the results back to Earth.

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MISSILES AND ROCKETS
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1962

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AF Buys Big Guidance Test Facility

With the ultimate goal of significantly reducing checkout time, the Air Force has ordered a complete inertial guidance test facility from Hughes Aircraft Co. The system, called VATE (for Versatile Automatic Test Equipment), will be installed at the Heath Annex of the Middletown (Pa.) Air Force Depot. It reportedly will be largest U. S. installation of its kind. The $4-million letter contract calls for system installation to begin in January, 1963, and first units to be in operation by the following April. Employing nine separate digital computer stations, VATE will be capable of testing up to 45 guidance systems simultaneously, developers say.

Laser Advances Pour in . . .

. . . *From RCA*. The company reports that use of a calcium-fluoride crystal doped with divalent dysprosium, a rare earth, has permitted development of a new pulsed laser that requires one-tenth the power of previous devices and emits a coherent infrared beam. The crystal emission can be triggered by a broad band of light energies varying from the infrared to ultraviolet regions of the spectrum. Developers believe they soon will be able to achieve continuous IR emission using only mercury or tungsten lamp light sources.

. . . *From Hughes*. The first pioneer in this exploding field of technology, Hughes Aircraft Co., reports it is ready to market a new product line of lasers. Priced at about $1000 each without power supply (or $2500 with), present units generate up to 10 kw peak power with a total beam energy of 1 joule. The first laser, Model 200, weighs 1 lb. and is about the shape and size of a soup can.

. . . *And From Marketeers*. Touted as "the first all-inclusive market research study on the subject," a new report is now available from Technology Markets, Inc., of New York City. Titled *Masers and Lasers: A New Market with Enormous Growth Potential,* the report was one year in the making. Cost: $200 a copy.

Atlas Radio Command Miniaturized

Flight units of the *Atlas* radio command guidance system now used in the *Atlas-Agena* series have been reduced to 33 lbs. from the original total of 244 lbs., say General Electric developers. Used in the recent *Ranger IV* lunar-impact attempt, the lightweight system proved to be one of the few successes in that shot. Volume has been cut from 3¼ cu. ft. to ¾ cu. ft. by transistorizing all electronic units.

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Crack Immunity Built Into Rubber Molecules

B. F. Goodrich scientists have succeeded in giving rubber and plastic molecules a built-in immunity to cracking, decomposition and oxidation effects by perfecting a process to completely saturate the molecules. The addition of hydrogen closes the sites existing in unsaturated molecules where oxidation attacks are prevalent. The method uses a soluble catalyst to pass in hydrogen under pressure. Because it is soluble, the catalyst has the maximum opportunity to contact the material to be hydrogenated. Although not yet commercial, the process points the way to new and better materials throughout the entire range of plastic and rubber products.

Inco's 9% Ni Steel Code-Accepted

Code acceptance has been granted by the Boiler and Pressure Vessel Committee of the American Society of Mechanical Engineers to International Nickel's 9% nickel steel. The material is designed for use in cryogenic applications down to −320°F, with no thermal treatment after welding. Inco says the steel remains ductile, has a proven low-temperature strength, and makes possible substantial economies in the construction of cryogenic vessels.

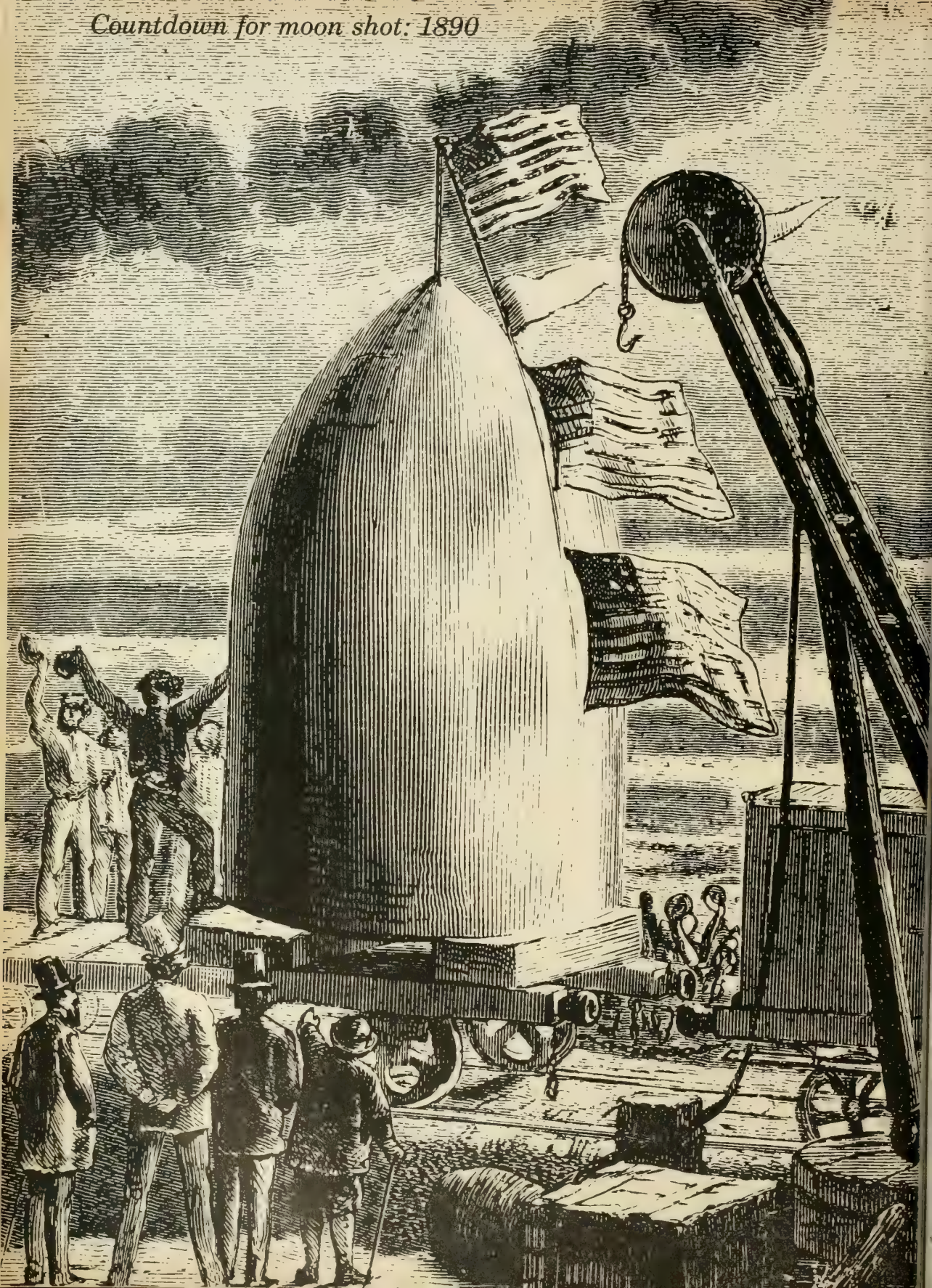
Solar Cells Simplest for Radiation Checks

Bell Telephone Labs researchers have completed a study showing that silicon solar cells can be used to measure high-intensity radiation. The cells involved are made by forming a thick layer of n-type semiconductor on a base of p-type semiconductor. For most applications, all that is necessary is to solder a couple of wires to a solar cell and connect them to a relatively inexpensive ammeter. A million rads per hour of X- or gamma-radiation would produce a current from the cell of 37 microamperes, easily measured on a moderately sensitive meter. Intensities as low as 100 rads per hour can be measured with more elaborate instrumentation and radiation as intense as 10^9 rads per hour can be handled, provided it is not too energetic.

Protein-Only Indicator Sought

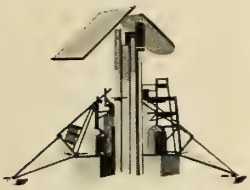
The Ford Motor Co. is searching for a dye which will change color when in contact with proteins—and only proteins. The search stems from a NASA contract involving a cheap method of determining the existence of life on other planets. An unmanned instrument package would bring the die in contact with local ground samples, match the color and radio the results back to Earth.

Countdown for moon shot: 1890



Finish the moon shot Jules Verne began 72 years ago!

Science fiction pioneer Jules Verne foresaw problems in hitting the moon. His fictional moonship missed its mark, after nearly colliding with a meteor.* Now, 72 years later, Hughes offers you the opportunity to be part of a real moon project.



Help us soft-land the Surveyor on the moon with a package of delicate test instruments. Or work with us on other sophisticated projects: VATE (versatile automatic test equipment); ARPAT (terminal anti-missile defense system); Mid-course anti-missile defense systems; BAMBI (ballistic anti-missile booster intercept); SYNCOM (synchronous-orbit communications satellite). Positions are open for senior and junior control engineers, circuit designers, electronic weapon systems analysts, mechanical engineers and infrared specialists, with degrees from an accredited university.

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*In Verne's 1890 novel, "From the Earth to the Moon," his spaceship, "Columbiad," was launched from Tampa, Florida—just 120 miles from Cape Canaveral! After missing the moon, the craft returned to earth at 115,200 miles an hour. It plunged into the sea, popped to the surface—and the three men inside were found "playing at dominoes."

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GPI Moves Toward Larger G&C System Role

Aerospace Group formed of Kearfott Division, new Systems Division, and Research Center is key to expanded effort

by Michael Getler

TARRYTOWN, N. Y.—General Precision, Inc., is making major organizational changes and investing some $5 million in plant expansion in an attempt to win more of the crowded missile/space guidance and control systems business.

The company recently announced the formation of a new Aerospace Group, composed of the long-standing Kearfott Div., a newly created Aerospace Systems Div., and the new Aerospace Research Center now nearing completion adjacent to the Kearfott plant in Little Falls, N. J., (M/R, March 19, p. 39.)

GPI President Donald W. Smith told MISSILES AND ROCKETS that the new Aerospace Group, to be headed by Fred D. Herbert, Jr., would account for about $103 million of GPI business in calendar 1962. This is roughly 40% of the company's total expected sales. Most of this business is existing backlog, from corporate headquarters and Kearfott, on *Subroc, Talos,* and *Pershing* G&C sub-systems and several aircraft programs.

Smith has conservatively estimated a 10% annual increase in business for the new group, putting sales at about $137 million by 1965.

Major new effort of the Aerospace Group, now headquartered at Little Falls in the Kearfott building, is a competition with the AC Spark Plug Div. of General Motors for development of a guidance and control system for the Air Force's Mobile Medium-Range Ballistic Missile. This current competition, Smith says, is a re-direction of earlier AF contracts to design and develop prototype stellar-inertial guidance systems for the Ballistic Systems Div. under the *STINGS* program.

In addition to the MMRBM effort, Smith reports, the company will seek guidance and control systems awards in the *Titan III* and NASA *Gemini* competitions, and will also bid on the industrial role in turning out MIT Instrumentation Lab's guidance and navigation package for *Apollo.* Smith pointed out that GPI has previously fabricated MIT-designed gyro and accelerometer components for the *Polaris* guidance system.



AEROSPACE GROUP President Fred Herbert will seek more broad systems contracts.

• **Planned shift to systems**—The decision to form the Aerospace Group is, according to company officials, part of the GPI's transition from a component-oriented firm to one with greater emphasis on complete guidance and control systems management capabilities. The first step in this direction was taken in 1959, when GPI, the major operating subsidiary of General Precision Equipment Corp., was formed.

The company, Smith asserts, will continue to pursue the subsystems role on some projects. But the trend among current major systems companies toward acquiring component lines of

(Continued on page 40)

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E. G. UHL, President, Fairchild Stratos Corporation

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Hollow Cathodes Cut EB

Martin development leads to cheaper electron beam welders by shaving high voltage, vacuum demands

THE NOVEL gas discharge characteristics obtained with hollow cathode structures are being exploited by Martin Co. scientists in the form of low-cost, high-pressure electron beam welders.

Successful welds have been made with tungsten, tantalum, molybdenum, titanium, stainless steel and some ceramics.

The main advantages over high-vacuum electron beam welding include simplicity, elimination of filament supply and filament, and greatly reduced high-voltage supply requirements. The welds were made with only about 3600 volts applied to the cathode. This upper limit was dictated by power supply limitations. Welds have been made with power inputs ranging from 600 watts to 3000 watts.

Another inherent advantage is the high-pressure operating range of the electron-beam-mode discharge welder. The vacuum ranges from 1 mm. Hg to 10^{-3} mm. Hg, a relatively high pressure when compared to high-vacuum units. This also cuts down the pumping hardware requirements and the time involved in pumpdown.

Cylindrical and spherical copper mesh cathodes have been used. The screen-wall hollow cathode acts as an electron trap with a leak at the aperture. An obstructed high-impedance glow discharge produces electrons on the cathode surface and these are used to maintain the discharge. The electrons formed on the interior are trapped in the cathode cavity and leak out in a well-defined beam.

- **Operational simplicity**—The per-





ABOVE RIGHT: *Cylindrical hollow mesh cathode produces well-defined beam. This particular beam has an elliptical cross-section resulting from certain voltage and pressure.*

LOWER RIGHT: *Experimental stainless steel butt welds were some of many made by Martin researchers. Development effort should narrow weld zone .*

Weld Costs

forated wall cathode is self-cleaning and operated well even in a "dirty" atmosphere. Operation is not interrupted by severe outgassing, material evaporation from welds and other normally undesirable products of high-temperature welding.

The unit is not limited to welding—refractory materials can be cut, even those which decompose at high temperatures.

The phenomenon was discovered by Martin researchers H. L. L. van Paassen and R. J. Allen in October, 1960. Hollow cathode discharges were being investigated as a possible effective way to clean substrates for thin film evaporative work.

While conducting these experiments, the researchers found that in the lower-pressure operating range, a new type of discharge was created. Where the normal cathode discharges had rapidly expanding glow regions, this type of discharge had a narrow, well-defined beam roughly 0.25 in. across and extending the length of the vacuum chamber. This sparked the development and research effort which led to the welder.

The collimated electron beam exists in two discharge modes—a luminous beam mode and a dark beam mode. The luminous beam is characterized by the production of a well-defined beam of electrons originating just within the cathode aperture. This beam has the form of a hollow cone with the focal point one to several cathode diameters above the aperture and its location a function of pressure and voltage.

The electron beam continues beyond this focal point in a column of luminous plasma, having a circular cross-section no larger than the cathode aperture diameter. Under certain conditions of pressure and voltage, cylindrical cathodes will produce columns having elliptical cross-sections of high eccentricity.

The dark beam mode is very similar to the luminous one except that no luminous column is produced beyond the focal point.

Martin researchers say the device and its applications are in the early stages of development, but there are no theoretical obstacles in view. The firm has patent coverage and expects to market the process. ⁂

MISSILE-SPACE
ENGINEERS and SCIENTISTS

The Aircraft-Missiles Division needs exceptional talent to spearhead accelerated growth into selected, key aerospace areas such as satellite and reentry systems, reconnaissance-surveillance systems, communications and power for space applications, and advanced missile systems. Basic prerequisites include appropriate degree, plus a minimum of three to four years' applicable experience.

ADVANCED SYSTEMS ENGINEERING

Requires increasingly more responsible experience in depth in space, reentry vehicle and satellite programs in control systems, guidance systems, sensor systems, communications systems, propulsion systems, data systems, computers (airborne), vehicle systems (reentry and space), recovery systems, command systems, biological and chemical systems.

SYSTEMS ENGINEERING

Must have had increasingly responsible experience in depth the last several years of which must have been in systems engineering in one or more of the following areas—control systems, guidance systems, sensor systems, communications systems, propulsion systems, data systems, computers (airborne), vehicle systems (reentry and space), recovery systems, command systems, operations research activities, applied mathematics.

ELECTRONICS ENGINEERING

Requires progressively more responsible experience in depth preferably as related to ballistic missiles, space and reentry vehicles, satellites and associated systems in such areas as data systems, radar, telemetry, tracking equipment, sensor equipment, guidance (command and inertial), control, computers, ground support equipment.

ENGINEERING TECHNOLOGIES

Must have had increasingly more responsible experience demonstrating ability to handle problems in one or more of the following areas—heat transfer-fluid flow, orbital mechanics, trajectory analysis, aerophysics, magneto hydrodynamics, applied mechanics, aerothermodynamics, space dynamics, numerical analysis, calculus of variations, statistics and information theory, materials engineering—metals and non-metals.

DESIGN ENGINEERING

Requires progressively more responsible and complex subsystem design experience and demonstrated excellence of capacity in handling such assignments in one or more of the following areas—propulsion, servomechanisms, vehicle structures, space power systems, electrical power and distribution, recovery systems, ground support equipment and environmental control.

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GPI's Aerospace Group

(Continued from page 37)

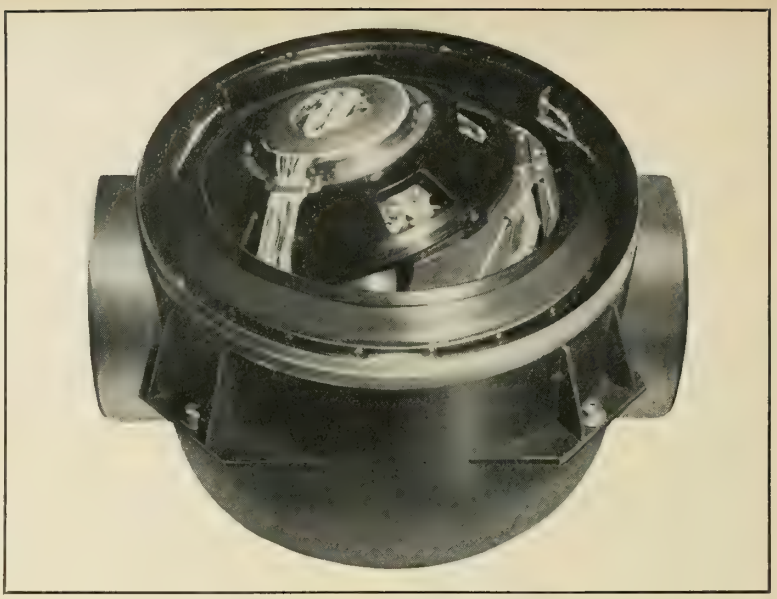
their own in making this less attractive.

The new Aerospace Group embraces about 7000 persons, and should eventually occupy about 1 million sq. ft. of plant space. The company has taken an option on 111 acres in northern New Jersey, near the Totowa-Wayne airport, where the Aerospace Group is expected to be headquartered in a year. The plant, to cost about $3 million, will be designed initially for about 150,000 sq. ft., expanding eventually to about one-half million sq. ft. The Research Center, slated for fall occupancy, will cost an estimated $2 million and occupy 70,000 sq. ft.

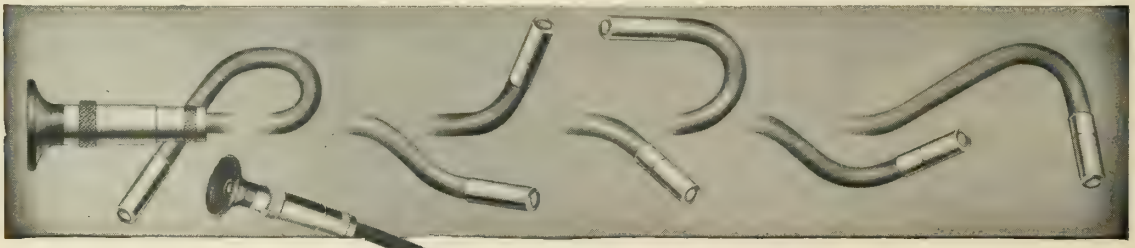
Key element in the new group is the Aerospace Systems Division, headed by Joseph B. Heimann, which is charged with creation and management of complete G&C systems.

Research support from the systems division, and also for Kearfott, will come from the Aerospace Research Center, under Dr. Robert C. Langford.

Smith also points out that the other operating divisions of GPI—in particular the aerospace computer branch of Librascope Div.—will likewise support the group. ⌗



NEW MINIATURE 4-gimbal inertial platform, developed within Kearfott Div. of GPI's new Aerospace Group, is being proposed for use in advanced G&C missile/spacecraft systems. The device, now in test phase, employs three floated rate-integrating gyros and three single-axis inertial accelerometers, weighs 14.3 lbs. and occupies less than ⅓ cu. ft. Unit is reportedly fully operational in 4½ min. from −65°F, draws 64 watts during warm-up, and 14 watts when operating. Modular design is included, with components interchangeable for adaptation to several inertial schemes. Platform is also compatible with either analog or digital platform elements.



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Phaeton—Most Advanced French Design

by Bernard Poirier

THE PRINCIPAL rocket producer in Europe has revealed the laboratory design of a high-utility satellite which France hopes to orbit within the next few years.

Appropriately dubbed *Phaeton* by scientists of La Société d'Etude de la Propulsion par Réaction (SEPR), the 660-lb. self-propelling satellite will produce 2.25 kw electrical power from a 135-sq.-ft. parabolic shield measuring 13.12 ft. across.

Phaeton's design is the result of efforts by several French research laboratories, spearheaded by SEPR. In view of its intended missions, it was necessary to offset admitted rocket-lift-off deficiencies by using some singular propulsion concepts using the sun as a reliable source of power.

A system which converts the sun's energy to electrical energy was developed after more than a year's research. This electrical energy triggers the propulsion unit and supports the working instrumentation payload.

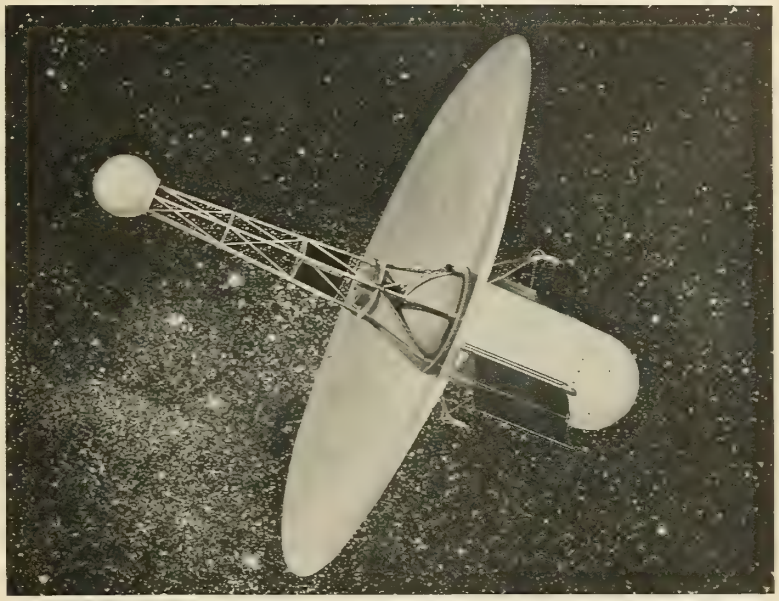
The parabolic reflector, folded during passage through the atmosphere, is designed to open once inserted into space, and concentrates the absorbed sun's rays on the entrance of a boiler. Here energy conversion vaporizes mercury circulating in the interior.

Heat is gathered and stored by lithium hydride circulating in the interior. This is required to restore the heat when *Phaeton* passes through the shadow portion of orbit.

Nearly analogous to water in a steam engine, the mercury cycle follows high-pressure steam released from the boiler (on the structure above the reflective shield). It is driven into a double compound-type piston motor in which the first cylinder executes only partial expansion.

Full expansion occurs during passage through nine other parallel cylinders. The mercury is driven first into a carter-motor and a fan-type radiator whose primary function is really a condensor. The resulting liquid mercury is pumped back to the boiler.

A vapor tube of high-pressure mercury assures the feeding of the pump after the liquid passes into a secondary radiator designed to avoid cavitation within the pump. The cycle then continues.



PHAETON, France's first high-utility satellite design, was developed by SEPR, largest European rocket producer. It may be used for 24-hour orbits.

Providing the electricity demanded by *Phaeton's* design is an a-c generator driven by the "mercury-steam" motor. The current drives high-temperature hydrogen stored in a tank reservoir behind the shield.

The hydrogen expands at two movable nozzles. But even in the propulsion stages only a portion of the available energy is utilized by this function. During this and subsequent phases, the instrumentation uses the electricity remaining or available.

• **Waiting for rockets**—Elated over the SEPR design, a company spokesman admitted 'it goes without saying we lack only the carrier rockets."

"These are very expensive," he added, "and involve booster vehicles and guidance which we will not have in Europe before the end of this decade." It is this deficiency which prompted a high-utility design to propel a satellite from a low orbit into a "24-hour" orbit —a feat not yet achieved in astronautics.

(One such satellite in orbit about 22.000 miles above the earth would be in line of sight of almost half the earth's surface. Three 24-hour satellites could provide virtual complete world communication coverage.)

Phaeton's first mission is to sweep or mop up the lower levels of space for traces and measurements of magnetism and radiation intensities, and for other applicable experiments.

A second, more ambitious, mission is attainment of a 24-hour orbit, which is suggested by the *Phaeton* propulsion design concept. This calls for 3000°K hydrogen heat temperatures during the satellite phases.

Resulting thermic-electrical propulsion is on the order of 20 g's. The trade-off between instrumentation weight and hydrogen capacity may equal 250 lbs., depending on the severity of the mission.

An obvious downstream mission for *Phaeton* is prolonged radio transmission. French scientists foresee tests involving plasma and ion ejection as well.

Phaeton is France's first truly sophisticated space research effort, the debut of a spacecraft which—as SEPR describes it—"neither duplicates nor mediocrely participates in American and Russian efforts." The limiting component in the French program remains the carrier vehicle. ⌘



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Review and analysis of Polaris system functional design to determine a proper error assignment on a computational criteria basis. BS or MS in mathematics. Four to ten years' missile systems reliability experience desirable.

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COSPAR Meeting

(Continued from page 16)

indicate that the altitude at which the ratio O^+/He^+ has a value of unity lies between 1000 and 1300 km, depending on the atmospheric temperature.

Atmospheric temperature in the upper ionosphere was found to be constant with altitude within a few percent. The authors developed an empirical relationship which predicts the altitude of the two transition levels as a function of diurnal time and of solar cycle.

A. E. Mikirov presented the results of brightness measurements made during geophysical rocket soundings in the temperate and northern latitudes of the USSR. On the basis of these measurements, he showed that there is an aerosol layer to at least 100 km where the measurements stopped. The author estimates the number of particles per unit volume and the density of the particles.

Two University of Colorado scientists used a specially designed balloon-borne coronagraph flying at 80,000 ft. to measure the skylight and thus determine the number of particles floating above the balloon. Their results confirm those of several other scientists: a "dust layer" exists in the Earth's atmosphere at approximately 60,000 ft. The origin of this layer is not clearly understood.

• **Electron densities** — An antenna impedence probe used to determine electron density in the ionosphere was on *Discoverer* satellite No. 34, launched Nov. 5, 1961. The satellite was in a near polar orbit with a 250-km perigee and a 1000-km apogee. On the basis of the probe data, J. C. Ulwick and W. Pfister of Air Force Cambridge Research Laboratories concluded:

—The electron densities measured at perigee below the peak of the F_2-layer compare favorably with ionosonde data.

—On the night side above 600 km the electron density is almost constant with a value of about 3×10^4 electrons/cm^3.

—On some of the orbits a pronounced peak with up to 2×10^5 electrons/cm^3 was observed at 650 km in the southern auroral zone. A systematic change of the results occurs as a function of position on the globe.

—There are day-to-day variations in the vicinity of the perigee in the E-zone.

Four National Bureau of Standards scientists confirmed the existence of a large number of radio-signal conducting ducts in the upper atmosphere. The work was done through two rocket firings from Wallops Island in June and October of 1961. Thomas E. VanZandt and his colleagues reported that these ducts—caused by stratified ionization irregularities—are aligned with the Earth's magnetic field and allow relatively loss-free propagation of low-frequency radio waves.

• **Solar effects on upper atmosphere** —On the basis of drag data gathered from eight satellites, Luigi C. Jacchia of the Smithsonian Astrophysical Observatory suggested mechanisms by which the sun affects the density and temperature of the atmosphere above 300 km.

He attributes heating of the upper atmosphere to both electromagnetic and corpuscular radiations. He estimated that corpuscular radiation accounts for 30% or more of the heating and he confirmed the semiannual variation in corpuscular heating recently found by two other scientists. Reaching its maximum in early April and October, corpuscular heating is said to increase during magnetic storms.

Jacchia's studies also show that electromagnetic (ultraviolet) heating is 35% higher in the daytime than at night.

The author observed a systematic decrease in temperature of the upper atmosphere during his work. Noting that this decrease parallels the general decrease in solar activity during the three years covered by the data, he suggested that the change results from the reduction in corpuscular radiation or solar-wind intensity.

Another scientist—D. G. King-Hele of the Royal Aircraft Establishment, Farnborough, England—also used satellite orbit data to study the variation in air temperature with solar activity. Since his investigations were made for the 1958-1961 time period and for the 200-500 km altitude range, his results augment those of Jacchia.

King-Hele reported that the general decline in solar activity caused the average day-night air temperature at the studied altitudes to decrease by almost 500°K—from more than 1700°K to less than 1300°K. He further reported that there is little sign of variation in upper-air temperature with latitude or season, and below 170 km solar activity does not affect air temperature.

• **Winds at any height**—Soviet scientists gave four out of the five contributed papers on winds.

G. I. Golyshev and his colleagues reported on their studies of the wind fields in the stratosphere, based on investigations carried on aboard the Russian ship Ob. Part of the work was carried out as the Ob cruised from the Amundsen Sea (64° 41′ S. Lat., 109° 46′ W. Long.) to Easter Island (27° 37′ S. Lat., 109° 25′ W. Long.).

During this passage, the scientists observed the exceptional constancy of western winds in the stratosphere and the existence of a vast zone of weak winds—less than 50 km/hr. ■

The Industry Week

Corporate Earning Picture Brightens

Three major aerospace firms reported substantial increase in sales and earnings over like periods last year. Lockheed Aircraft Corp. reported earnings of $1 per share in the first quarter of 1962, up from $.59 in the same period of '61. Satellites, space research and missiles accounted for $196 million of a total $393 million in sales. Boeing profits rose to $1.01 a share for the quarter, up from $.75. On March 31, the company had a $243-million backlog for missile and space programs. RCA board chairman David Sarnoff told a stockholders meeting the company expects record earnings and sales for the six months ending June 30, but he disclosed no figures.

News of Mergers and Acquisitions

Bell & Howell Co. and DITTO, Inc., merger has been approved by stockholders of both companies. When the merger is effective, DITTO will operate as a B&H subsidiary. . . . *The Siegler Corp. obtained option to purchase all capital stock of Trion Instruments, Inc., Ann Arbor, Mich. Trion specializes in research and manufacture of laser devices. The option runs until July 20, 1962.* . . . Cherry-Burrell Corp., Cedar Rapids, Iowa, acquired the Magnilastic Div. of Cook Electric Co., Chicago, manufacturer of expansion joints, piping accessories and other equipment. . . . *Dynamic Gear Co., Inc. acquired the assets of Daddio Bros. Co., Lindenhurst, N.Y., specialists in precision screw machine work.*

International News Briefs

Warnecke Electron Tubes, Inc., a new joint U.S.-French microwave electronics firm, is building a plant in Des Plaines, Ill. The firm is owned jointly by Hallicrafters and Compagnie Generale de Télégraphie Sans Fil (CSF), Paris. . . . *Maj. Gen. Clarence A. Shoop, Hughes Aircraft VP and International Div. director, has been appointed to the Export Expansion Council by Commerce Secretary Hodges.* . . . Hengst-Donaldson G.m.b.H, Munster, West Germany, will be set up in Munster to produce air cleaners and filters for the European Common Market. The company will be a joint venture of Donaldson Co., Inc., Minneapolis, and Walter Hengst, a West German manufacturer and engineer. . . . *Electronic Associates, Inc., was awarded a contract by the India Supply Mission to produce what is believed to be the first computer for India. The unit will be installed at the Ministry of Defense in New Delhi and will be used by Indian companies and organizations engaged in scientific research projects for the government.*

New Industry Facilities

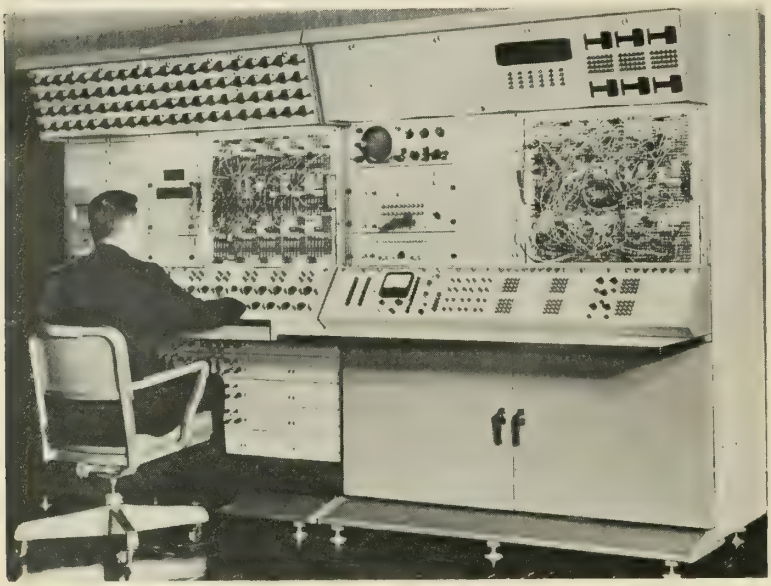
Lionel-Pacific, Inc., subsidiary of the Lionel Corp., will combine all operations in a new 160,000-sq.-ft. facility in San Diego next fall. . . . *Grumman Aircraft Engineering Corp. completed installation on four new Space Age facilities costing $2.5 million. Facilities include an environmental space simulator, a sine-random vibration system (structural shaker), a centrifuge and a clean room. The space chamber can simulate altitudes of 300 miles, and has an inside clear test volume of 15-ft. diameter by 20-ft. height.* . . . RS Electronics Corp., Sunnyvale, Calif., broke ground for new facilities. The company is active in the field of miniature electronic equipment, and is a subsidiary of Regan Industries, Inc. . . . *Dynatronics, Inc., opened an addition to the company's Central Florida plant in Orlando.* . . . Clevite Electronic Components will more than double its existing manufacturing facilities in Bedford, Ohio. . . . *Litton Industries Guidance/Control Systems Div. is adding 24,000 sq. ft. to its Woodland Hills, Calif., facilities. The company's Data Systems Div. has leased over 61,000 sq. ft. in Canoga Park, Calif., to house research, development and engineering departments.*

New Names in The Industry

Management Technology Inc. has been formed to provide intellectual and financial resources for advancing management concepts and techniques for military, scientific, industrial and commerical clients. Offices have been opened in Washington, D.C., and Los Angeles. President is Donald G. Malcolm, who was supervisor of the original PERT design team for the Navy's *Polaris* program. . . . *Reynolds Rocket Systems, Inc., La Puente, Calif., has been formed to perform research, engineering and manufacturing for the aerospace industry. The company has acquired a 10-building facility, including research labs, production and assembly areas, test cells and R&E offices. They produce solid-propellant rockets and rocket systems and perform R&D of unique systems for use in outer space.*

Corporate Division Changes

Antenna Systems, Inc., Hingham, Mass., formed an Electronic Systems Div. to plan, engineer and install complete antenna tracking systems. The division, in Maitland, Fla., will be under the direction of Vaudie W. Vice. . . . *Motorola has formed an Antenna and Microwave Group to ". . . accelerate our activities in the fields of advanced antenna systems and associated electronics."* . . . Jonathan Manufacturing Co., Fullerton, Calif., formed an electronics Div., Jonathan Electronic. New facilities will be devoted to the design and manufacture of automated test equipment for electronic components and subassemblies. . . . *Babcock Electronics Corp. formed a coder-decoder section within its Engineering Div. to conduct design research in all phases of electronic development concerned with coding and decoding digital data.* . . . Dynatech Corp. formed an Aerospace Project Dept. to develop an advanced propulsion concept for an orbiting space vehicle. . . .



New Product of the Week: Hybrid Computer Perfected

A HYBRID computer combining the operational features of analog and digital computers into an integrated system has been developed by Electronic Associates, Inc.

The computer, designated HYDAC (hybrid digital/analog computer), was designed primarily as a scientific instrument for a range of research, design and development applications in industry, defense and civilian space programs as well as commercial applications for a variety of design and production problems.

The traditional advantages of both analog and digital computers—the analog's speed, lower cost, ease of programing and the digital's capacity for data storage, decision-making logic operations and time sharing of components—have been combined into one centralized system to achieve a computation efficiency well beyond the limits of either computer used alone.

The initial major units of HYDAC include a general-purpose EAI 231R analog computer and a digital console with an expandable complement of logic and memory components. A significant feature of the digital unit is the modular and self-contained design that permits large-scale analog computers now in use to be updated conveniently to include digital capabilities.

Circle No. 225 on Subscriber Service Card

Miniature Inductors

The UTC Miniductor series of miniature inductors is suited for transistor and printed-circuit applications.

All units are manufactured and guaranteed to MIL-T-27A by full environmental testing. They are available in inductances up to 5 henries and are adjusted to a tolerance of ±1%. The MW-.75 has a Q of 70 at 10KC. Applications range is in the audio frequencies. Temperature stability is from −55°C. to 100°C. The units are hermetically sealed in a molded case: size is $^{23}/_{32}$-in.-dia. x $^{13}/_{32}$-in.-high; weight is .25 oz. The two straight pin terminals are spaced ½ in. on center and have a diameter of .040 in.

Circle No. 226 on Subscriber Service Card

Solid-State DC Amplifier

An airborne solid-state d-c amplifier is announced by Crestmont Electronics, a division of Crestmont Consolidated Corp. The Model 1001, using silicon transistors to meet the ±100°C temperature environment, features fully isolated input and output with respect to chassis and power supply ground, and is available with a gain of 500 to 1500. Frequency response is within 1 db from d-c to 150 cycles. Voltage offset is less than 50 microvolts referred to the input. A pair of silicon-alloy transistors are used as a summer-comparator of a transformer-coupled a-c amplifier, and the input impedance is no longer limited by load, but approaches a value of 50,000 ohms.

Circle No. 227 on Subscriber Service Card

Terminal Insulator

A quick and easy method of insulating wire terminations and connections has been introduced by The Thomas & Betts Co., Inc.

The Heat Shrinkage Insulators are special irradiated polyolefin sleeves that are slipped over wires, taper pins, connectors, splices or terminals. When exposed to temperature of 275°F for a few seconds, they shrink in diameter by as much as 50%, providing a snug fit which conforms to the shape of the wire and terminal. The insulated connection



is semi-rigid, with high dielectric and mechanical strength. The heat gun has a specially designed nozzle to distribute uniform heat to the insulator in seconds.

Circle No. 228 on Subscriber Service Card

Current Power Source

Mid-Eastern Electronics has announced development of a new miniature portable power source MP 40-0.5. DC output is 0 to 40 volts at 0 to 500 ma, regulation 0.05%. It is designed for convenient bench use to provide bias and other voltages. It can also be used as a component of an automatic system, since it can be programed at 500 ohms/volt from a distant point.

Circle No. 229 on Subscriber Service Card

Time Code Reader

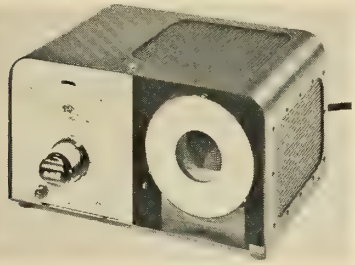
The time code reader developed by United ElectroDynamics, Inc., decodes serial IRIG time code for operation of the time selectors to provide precise automatic programing of instrumentation and control systems. When used with played-back tape signals, the unit

may be used for automatic editing and programing of data-processing sequences. Time Selectors may be pre-set to activate any given function with an accuracy of better than one millisecond. Resolution and range of times selected can be provided to meet specific requirements.

Circle No. 230 on Subscriber Service Card

Calibration Standard

Radiation Electronics Co. has announced a Calibration Standard operating in the temperature range of 150 to 1000°F which features a proportional temperature controller with a control precision of ±2°F. The unit also fea-



tures a large 2⅛-in.-dia. aperture that permits calibration without critical alignment problems.

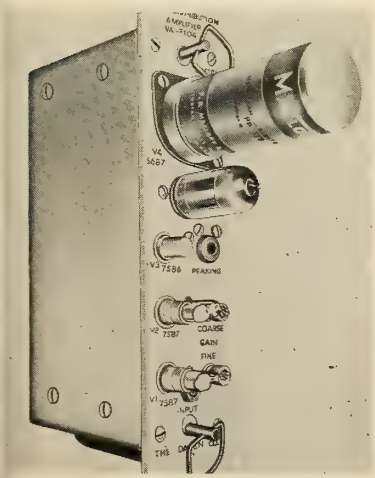
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Plug-in Pre-amplifier

A plug-in pre-amplifier has been added to the line of video distribution equipment produced by The Daven Co., a subsidiary of General Mills, Inc.

Eight amplifiers modules plug into one VA-S-101 shelf, using only 8¾ in. of vertical panel space. Coarse and fine gain controls on the front panel adjust to full gain. Gain may be varied from one extreme to the other with negligible change in frequency response.

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C. A. Haag: Promoted to vice-president of manufacturing, and **Paul Payette** to secretary-treasurer, Precision Castings Co.

Harvey F. Pierce: Elected president of the National Society of Professional Engineers. He is a partner in the Miami, Fla., firm of Connell, Pierce, Garland, and Friedman.

Dr. Launor F. Carter: Appointed Air Force Chief Scientist. He is vice president and director of research at System Development Corp., Santa Monica, Calif. He will be on a year's leave of absence from SDC to accept the AF post.

Ralph S. White, Jr.: Elected president and director of Pacific Electro Magnetics Co., Inc., Palo Alto, Calif.

Walter R. Graalman: Appointed director of materiel, Martin Co. He will be responsible for company-wide purchasing policies and practices. He will also direct and coordinate Martin's program of purchases from small businesses.

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James E. Osterman: Named treasurer of Zero Manufacturing Co. He was formerly manager of accounting for North American Aviation's Autonetics Div.

H. W. Hanley: Appointed general manager of the Montrose Div. of The Bendix Corp. He was plant manager of the division before being named to the newly-created post.

William C. West, Jr.: Elected vice president of Gulton Industries, Inc., and manager of the electronics research and manufacturing company's newly-formed General Industrial Group.

James D. Gow: Appointed president and general manager of Radiation Counter Laboratories, Inc., Skokie, Ill. He has been the vice president of RCL since 1959.

Maj. Gen. P. H. Robey, USAF (ret): Appointed to the management staff of the Garrett Corp.'s AiResearch Manufacturing Co. He will serve as the company program manager for project *Spur*.

Dr. Carl E. Faflick: Appointed director of the advanced systems planning organization of Sylvania Electronic Systems, a division of Sylvania Electric Products Inc.

L. M. Pease: Appointed to the newly-created post of director of business planning for the Ordnance Operation of Avco's Electronics and Ordnance Div.

Robert J. Maroni: Elected assistant vice president-defense marketing for General Precision, Inc., a new company position.

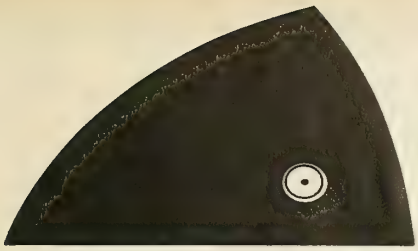
Lawrence V. Nagle: Elected president of The Udylite Corp. He succeeds **Clyde H. Reeme,** who retired April 30. Reeme will remain with the firm as a director.

Roger Lewis: Elected chairman of the board, General Dynamics Corp., in addition to being president and chief executive officer. **Earl D. Johnson** was re-elected vice chairman and **Henry Crown** re-elected chairman of the executive committee.

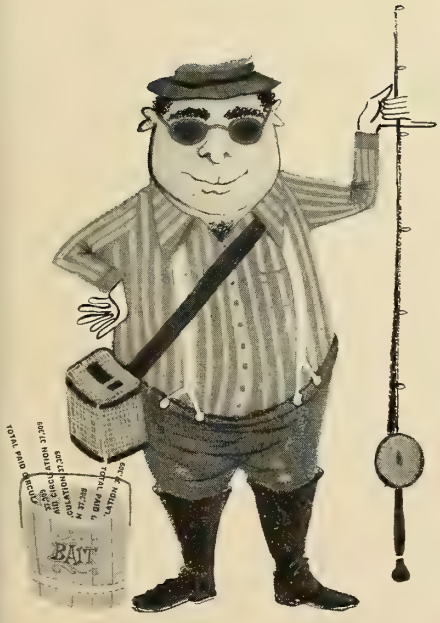
Col. Charles Brown: Will retire from the Air Force at the end of May. He is information officer at Edwards AFB. **Lt. Col. Dave O'Hara,** from AF headquarters, Washington, D.C., will replace Brown.

G. O. Haglund: Elected vice president of Vitro Corp. of America. He will be in charge of planning and corporate development.

Wallace R. Wannlund: Appointed head of the Ballistic Missiles Design Section, Space Technology Labs, Inc., Engineering Design Dept.



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—contracts—

AIR FORCE

$24,970,057—**Boeing Co.**, Seattle, for research and development for the *Minuteman* ICBM weapon system (supplemental contract).

$10,200,000—**General Motors Corp.**, Detroit, for production of *Titan II* inertial guidance systems (2 contracts). Work to be done in Milwaukee.

$5,378,000—**Philco Corp.**, Palo Alto, Calif., for activities in connection with the satellite control subsystem program.

$5,000,000—**Reeves Instrument Corp.**, subsidiary of **Dynamics Corp. of America** for manufacture of precision tracking radars. Work to be done at Garden City, N. Y., plant.

$2,831,150—**Aerospace Corp.**, El Segundo, Calif., for providing systems engineering, technical direction, management services and administrative support for ballistic missile and space programs.

$2,750,194—**Missile Systems Corp. of Texas**, Carrollton, Tex., for production of pylon assemblies for F-105D jet aircraft.

$2,100,000—**Lockheed Aircraft Corp.**, Burbank, Calif., for research and development on a classified program (supplemental contract). Work to be done at Sunnyvale, Calif.

$1,550,000 — **Aerojet-General Corp.**, Azusa, Calif., for fabrication, assembly and checkout of space boosters.

$1,496,612—**Aerojet-General Corp.**, Sacramento, Calif., for fabrication and delivery of *Titan* propulsion systems and related material.

$1,471,500 — **McDonnell Aircraft Corp.**, St. Louis, for design, fabrication and testing of re-entry vehicles (supplemental contract).

$1,194,482—**Martin Marietta Corp., Aerospace Div.**, Baltimore, for the TGAM trainer missile and related equipment.

$500,000—**Martin Marietta Corp., Aerospace Div.**, Orlando, Fla., for research, development and testing of new version of the GAM-83 *Bullpup* air-to-surface missile.

$188,570—**Electro Optical Systems, Inc.**, Pasadena, Calif., for work in optical surveillance devices and techniques using lasers.

ARMY

$6,907,806—**Thiokol Chemical Corp.**, Marshall, Tex., for igniters for missile motors.

$6,000,000—**Bendix Corp.** for classified project at Baltimore.

$1,513,291—**Aircraft Armaments Co.**, Cockeysville, Md., for training devices for the *Sergeant* ballistic missile systems.

$467,851—**Eclipse-Pioneer Division of Bendix Corp.**, for replacement parts for the *Pershing* ballistic missile guidance and control system. Work to be done at Teterboro, N. J., plant.

$1,150,000—**Raytheon Co.**, for manufacture of components to support the *Hawk* air defense guided missile program in NATO countries. Work to be done in Andover, Lawrence and Lowell, Mass.

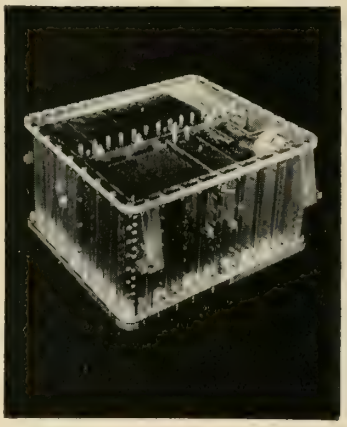
$152,767—**Sperry Rand Corp.**, Salt Lake City, Utah, for *Sergeant* missile ground handling equipment (3 contracts).

NAVY

$11,096,155—**Sperry Gyroscope Co.**, Great Neck, N. Y., for management of new design, production and installation work on submarine navigation systems for the *Polaris* fleet ballistic missile program (3 contracts).

General Instrument Corp., for designing and developing oceanographic instrumentation and conducting underwater studies for the *Polaris* program. Work to be done at Westwood, Mass. and Hicksville, N. Y.

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—when and where—

MAY

Annual Meeting of the Society of Photographic Scientists and Engineers, Hotel Somerset, Boston, May 7-11.

2nd National Conference on Peaceful Uses of Space, sponsored by the National Aeronautics and Space Administration, Seattle World Fair, May 8-11.

1962 American Electronic Components Conference, sponsored and participated in by American Institute of Electrical Engineers, American Society for Quality Control, Society of Nondestructive testing, Marriott Motor Hotel, Washington, D.C., May 8-10.

Instrument Society of America Show, sponsored by Society's Huntsville Chapter, Fort Raymond Jones Armory, Huntsville, Ala., May 9-10.

10th Anniversary Meeting of the Operations Research Society of America, Shoreham Hotel, Washington, D.C., May 9-11.

1962 Design and Drafting Spring Seminar, sponsored by American Institute for Design and Drafting, St. Louis, May 18.

8th National Aero-Space Instrumentation Symposium, sponsored by The Instrument Society of America, Marriott Motor Hotel, Washington, D.C., May 21-23.

1962 National Telemetering Conference, Sheraton Park Hotel, Washington, D.C., May 23-25.

Annual Meeting and Conference of Aviation/Space Writers Association, Mark Hopkins Hotel, San Francisco, May 20-26.

International Space Aerorama, Miami, Fla., May 25-27.

The First Annual Convention of the American Association for Contamination Control, Jack Tar Hotel, San Francisco, May 28-30.

JUNE

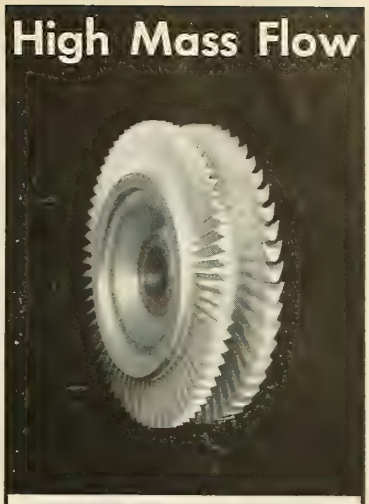
Summer General Meeting of the American Institute of Electrical Engineers, Denver Hilton Hotel, Denver, Colo., June 17-22.

Summer Institute in Dynamical Astronomy, Yale University, June 25-Aug. 3.

Cornell University Seminars in Industrial Engineering Operations Research and Statistics, Ithaca, N.Y., June 12-15.

JULY

Reliability Training Conference, sponsored by American Society for Quality Control, Princeton Inn, Milwaukee, July 8-15.



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Security—the Real Threat

DURING THE PAST FEW WEEKS, we have had an opportunity to talk to contractors in several parts of the nation about some mutual problems.

One question that confronted us almost everywhere was: "What do you think of the new regulation banning release of news on military spacecraft launches?"

This inevitably touched off a discussion of government security policies. We feel it is time for a few blunt words on the subject.

We are, to be frank, not overly concerned with the decision to classify the payload on spacecraft launches, which is not in fact a military decision.

Classifying additional payloads makes less evident the launching of a *Samos* satellite. The desire to conceal the existence of *Samos* is not motivated by military needs. It is a political decision based on the hope the Russians will join us in pretending it doesn't exist, thereby averting any international unpleasantness about "spy satellites."

While inconvenient from a news standpoint, this does not in itself constitute any severe threat to the welfare of the industry.

But the *Samos* approach—with some of its foolish efforts to retroactively classify parts of the program which previously have been declassified—is indicative of an Administration attitude which is becoming increasingly a threat to the welfare of both the industry and the nation.

Recently, an Air Force officer told representatives of a southwestern contractor: "Do not talk to anyone from *Aviation Week* or MISSILES AND ROCKETS. They are always breaking security."

A spokesman for the contractor quite properly informed the officer of the necessary role of trade journals. He also suggested, quite pointedly, that if the Department of Defense set its own house in order regarding security and the clearance of press releases, a considerable part of the problem would be solved. We could not agree more.

First, let us make it clear that MISSILES AND ROCKETS cannot "break" security. We have no government contracts, no security clearances and no access to classified information.

Because we concern ourselves daily with coverage of missile/space activities, we are often in a position to add two and two and come up with something other than four. If Mr. Khrushchev's espionage network and military experts do not have the same capability, they deserve banishment to Outer Mongolia. It is not generally known, but there have been instances, both on this magazine and on *Aviation Week*, in which experienced reporters have produced articles involving technical areas which might not have been known to the Russians. These stories went into the file and were not printed.

As a result, both publications have in the past been "scooped" by rival magazines on such stories.

Yet we frequently are accused by unknowing lower-echelon military officials of being scoop-hungry publications. On the other hand, when we sometimes have printed what one military officer has told us, we are charged by another with a breach of military security. We are getting somewhat fed up with this nonsense.

President Kennedy last year urged the nation's press to refrain from printing classified information. The President, a former newspaperman, should know better. The proper place for security emphasis is at the source, not after it reaches a journalist.

The Department of Defense should set up an efficient system of absolutely minimum military security and stick to it. When Arthur Sylvester took over the DOD press job, we heard some grandiose promises about things to come. These have not matured and the confusion has, if possible, worsened.

We can cite a number of examples. One contractor, after trying for weeks to clear news of a new contract through DOD security, read about the contract in this magazine. Where had we gotten the information? From a list of government contracts released by the Commerce Department.

Another firm, after weeks of trying unsuccessfully to clear a photograph, fount it printed in an unclassified military publication. Press releases have been held up for days while military officers argued, not over classified facts, but over wording of the announcement.

NO ONE TALKS about the result of this idiotic policy, but it is time someone did—for it is the key to borderline security leaks. DOD's own ineptness, in fact, encourages contractors to circumvent DOD when it appears they can get away with it. It certainly isn't a healthy basis for a sound security system.

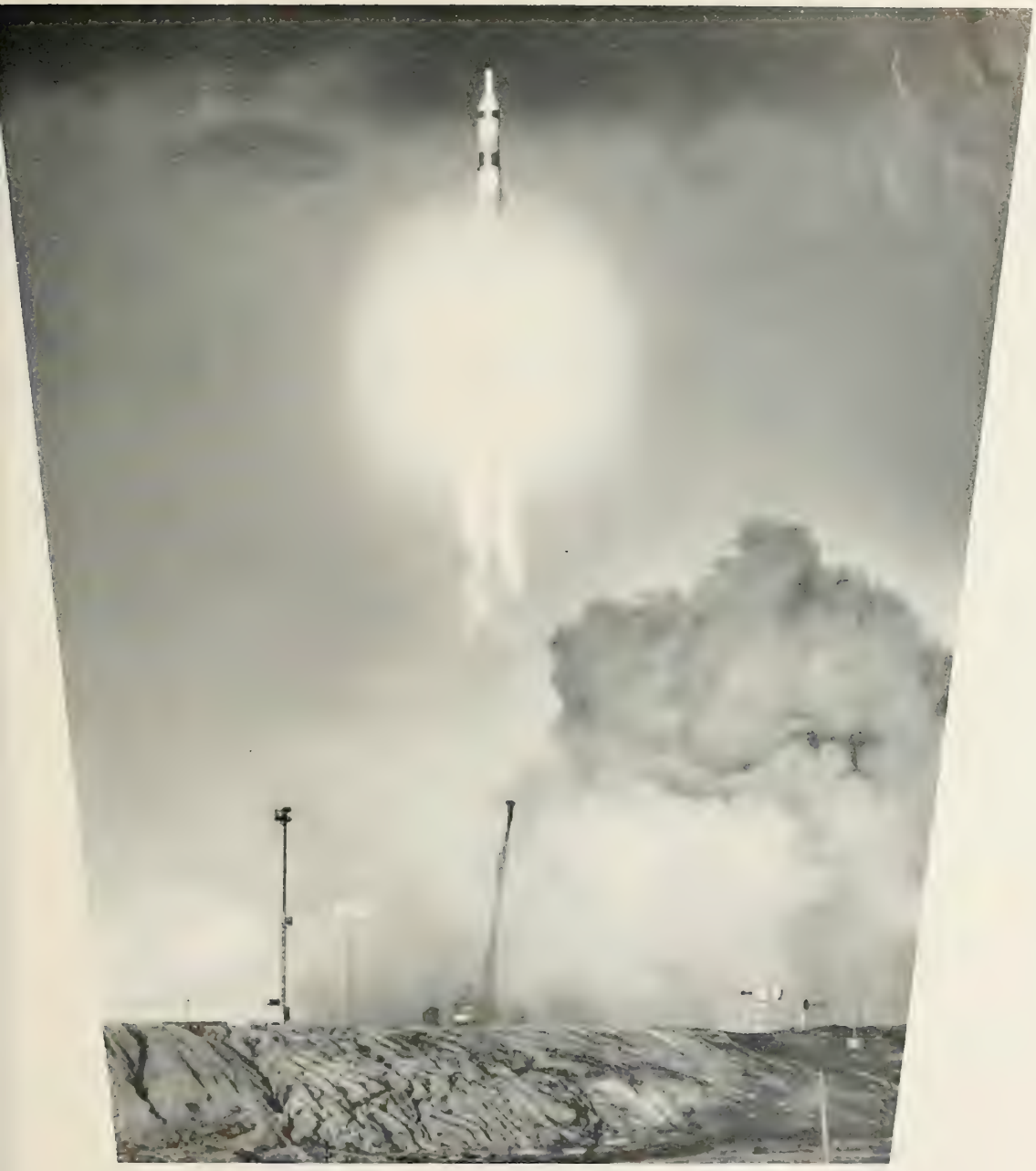
If DOD wants observance of security regulations, it should simplify them, use them only for bona fide military security, and set up an efficient organization to process contractor press releases as fast as possible.

The extremely important role of the weekly trade journals in the industry also should be acknowledged. Our task is to disseminate technical information throughout the industry as quickly as possible, in order to advance the state of the art and reduce unnecessary duplications of effort to a minimum.

We are as concerned with possible aid and comfort to the enemy as any other good American—probably more so, because we are in a position to appreciate the threat.

But any obstacle to the rapid flow within this industry of the maximum amount of technical information is more of a danger to the nation than anything which appears in these pages.

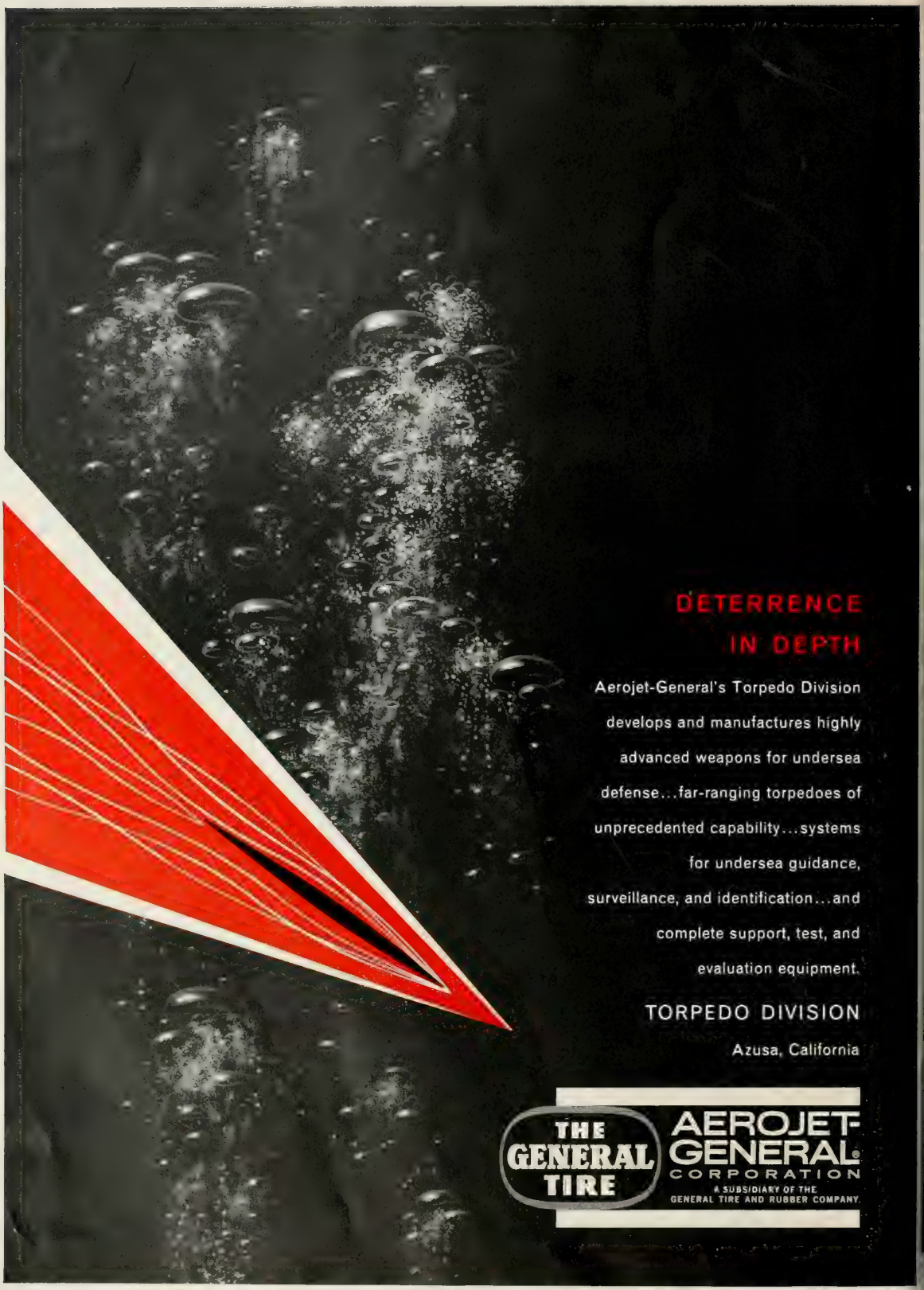
William J. Coughlin



FIRST TITAN HARDBASE GOES OPERATIONAL. The nation's first Titan ICBM hardbase is now operational at Lowry Air Force Base, Colorado. It is rugged enough to survive and retaliate from a near hit by a nuclear bomb. It is the forerunner of many similar underground launch sites now being readied to serve with the Strategic Air Command as guardian of world peace.

Martin Company, the aerospace division of Martin Marietta, designed and built Titan for the U. S. Air Force and is the integrating contractor for Titan hardsites.

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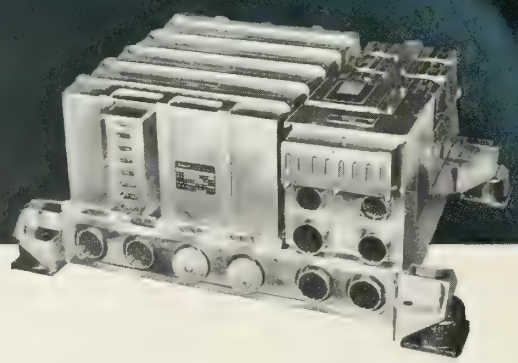
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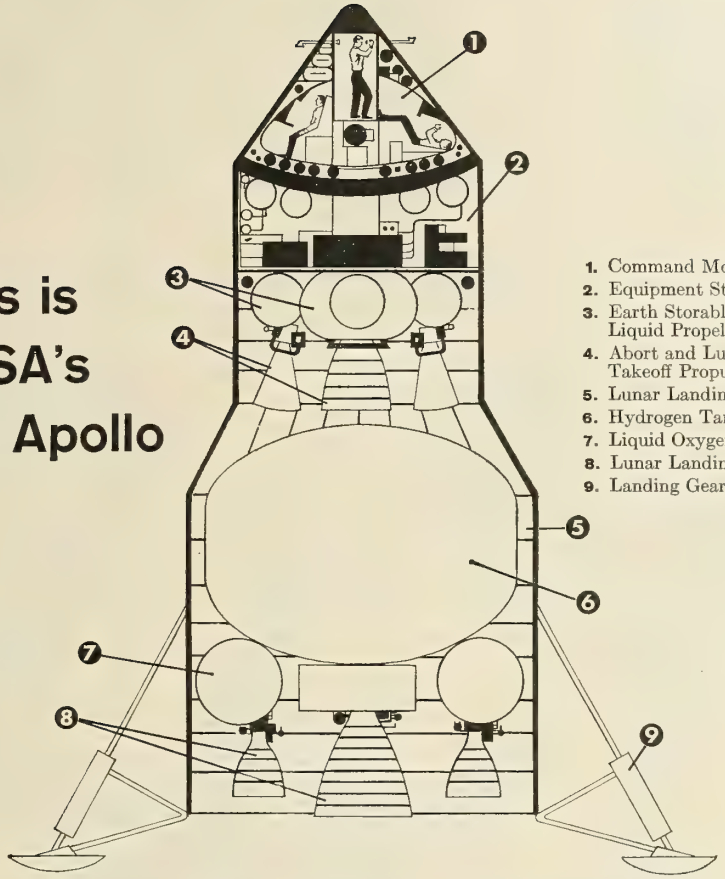
Sometime this year, CENTAUR will be spaceborne. Already, the projected uses of CENTAUR bear fascinating implications for the future... placing a satellite in an orbit so exacting that it will remain in one spot over the earth's surface... soft landings on lunar and planetary bodies... timed launchings of several satellites from a single vehicle. Several major guidance functions will be performed in CENTAUR by a compact digital computer system from Librascope. It weighs 62 pounds, occupies little more than $\frac{3}{4}$ cubic foot. A note to Librascope outlining your control problems will bring a prompt answer from the country's most versatile manufacturer of computer control systems.

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The men of NASA are readying for a journey that will surely be one of the most significant achievements of this century—Project Apollo, the landing of men on the moon and their safe return to earth. It will happen before this decade is over.

The project will proceed in three stages. Before the culminating voyages to the moon, three-man Apollo spacecraft will first orbit the earth for as long as two weeks. Next, spacecraft will head out toward the moon, circle it and return to earth.

The end product of Project Apollo and NASA's other space programs is not just placing a man on the moon, but the release of a flood of knowledge and benefits for mankind through research and development. We will chart the last unexplored sea on the map—the great void of space; we will improve weather forecasting (where even a 10 per cent gain in accuracy would save the nation billions of dollars every year); we have already taken the first steps in establishing a global system of communications satellites; and we may expect new products and new techniques that will stimulate the entire industrial spectrum.

Still, the advances in scientific knowledge hold the exciting promise of much greater returns, far beyond what earthbound man can possibly envision.

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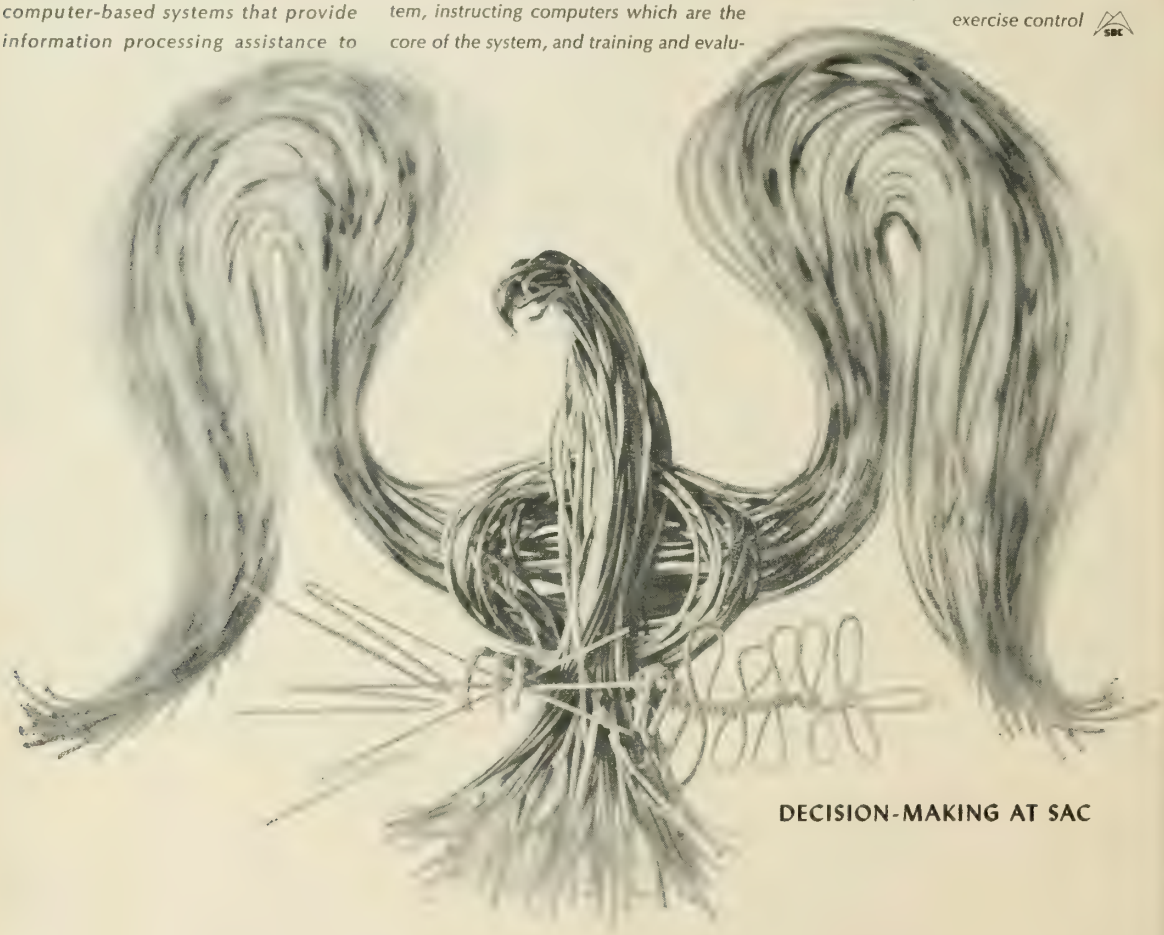
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THE WEEKLY OF SPACE SYSTEMS ENGINEERING

missiles and rockets

Volume 10, Number 20 May 14, 1962

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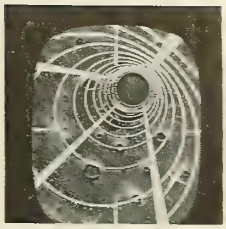
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THE COVER

Contact Analog ("Conalog") display system developed by Norden, and similar system by GE, used concentric cones to guide pilot to landing. Concept devised for sub and aircraft use is now urged for space. *See p. 31.*

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letters

The NASA-AF Plot

To the Editor:

I thoroughly enjoyed reading your perceptive and well-written editorial ("The Gleeful Conspiracy") in the April 23 issue.

O. B. Lloyd, Jr.
Director
Office of Public Services and Information
National Aeronautics and Space Administration
Washington

Silicone Fluid Coolants

To the Editor:

I have just finished reading your article entitled "Silicone Fluid Shows Potential as Space Coolant" (M/R, March 19, p. 22).

In the fourth paragraph you state that "XF-1053 is the only fluid available meeting the new closed cup flammability test being considered by the Air Force and proposed Air Force requirements for an electronic coolant in the silicone temperature range to replace organic fluids."

The evaluations of cooling fluids for the Air Force were conducted by Hughes Aircraft Company. Their proposed considerations form the basis for the proposed Air Force specification. On page 91 of WADD TR 61-186 report, issued by Hughes Aircraft Co., the fluids that were recommended for use in the —80 to 400 degree temperature range were Dow Corning XF-1-0158, Dow Corning 200 Fluid, 20 centistokes, as well as General Electric's SF-85, 20 centistokes, and GE's SF-97, 20 centistokes. Subsequent changes by the Air Force in their proposed specification have eliminated all of the recommended fluids, excepting Dow Corning XF-1-0158 Fluid.

Based upon the data that you presented in your article, it is apparent that General Electric's XF-1053 Fluid will also meet the proposed Air Force specification. It appears that still another fluid under development by Dow Corning, designated XF-1-0204, will also meet all of the requirements set forth by the Air Force.

K. R. Anderson
Assistant Manager
Electronic Industry Sales
Dow Corning Corporation
Midland, Mich.

Military Space Issue

To the Editor:

I wish to thank you and, at the same time congratulate you, on the fine March 26 issue of MISSILES AND ROCKETS. Many favorable comments have been received from the top military and civilian personnel here at ASD.

Ralph R. Springer
Lt. Colonel, USAF
Director of Information
Aeronautical Systems Div.
Wright-Patterson AFB, Ohio

Security

To the Editor:

May I congratulate you on this very fine objective editorial ("Security—the Real Threat", M/R, May 7).

Without your weekly information, I for one would not know where we stand in this new and exciting business of missiles and space.

John J. O'Brien
104 Ocean Spray Ave.
Satellite Beach, Fla.

Hunley Reading

To the Editor:

The USS HUNLEY (AS-31) complement is approximately 50 officers and 1000 enlisted men. When deployed in support of *Polaris* Missile Submarines, an additional 600 men will make use of HUNLEY tender facilities. These personnel will include submarine crews, civilian technicians, bureau representatives and transient personnel.

A majority of personnel aboard are highly motivated and selected for specialized duties. They are primarily students who will be using magazines provided in the library regularly.

We will have a number of personnel who will be especially interested in MISSILES AND ROCKETS.

W. D. Cooper, Chaplain
USS Hunley (AS-31)
Fleet Post Office
New York, N. Y.

Dutch Collector

To the Editor:

At the moment I just received your MISSILES AND ROCKETS issue of March 26 (the special Military Space Systems Issue), from one of my friends of the Royal Dutch Airlines (K.L.M.) at Amsterdam.

I may inform you that since 1957 my collection has been started. My archives encloses photos and signatures of rocket scientists all over the world. For instance Dr. von Braun, Cmdr. in Chief Thomas S. Power (S.A.C.), Vice Adm. W. F. Raborn, Jr., all the American astronauts as well as the Russian astronauts, further documents of Prof. Herman Oberth, Dr. Walter R. Dornberger, Prof. Hideo Itokowa (Japan), etc.

Further, I may inform you that during the last year I have had an interesting correspondence with Mrs. Robert H. Goddard. I also sent her some magazines of my country, which showed her my archives. As I am very interested in the work of Dr. R. H. Goddard, she also sent me her husband's autograph. Further, I received some pictures of her husband as well as her photograph, one made by her husband in 1937.

Theo Brouwer
Dutch Space Travel Archives
Eemsstraat 48-Amsterdam-Z
Holland

—reviews—

TABLES FOR THE COMPRESSIBLE FLOW OF DRY AIR, E. L. Houghton and A. E. Brock, St. Martin's Press Inc., 96 pp., $3.25.

Here is a handy and low-priced book of tables for the aerodynamicist and thermodynamicist who has tired of flipping through countless texts to find the air-flow data he wants. There are 64 pages of tables plus 32 pages of concise but clear and pertinent text giving the theory behind the tables. The authors say they have produced "an entirely new set of tables" for the parameters of isentropic, Prandtl-Meyer expansive, Rayleigh, Fanno, plane normal and plane oblique shock flows. The Mach number range is from 0 to 4, and gamma =1.403.

STATISTICAL ANALYSIS AND OPTIMIZATION OF SYSTEMS, E. L. Peterson, John Wiley & Sons, New York, 190 pp., $9.75.

Based on a series of lectures given by the author at General Electric, this book "is intended to provide the student and others working in the fields with an understanding of the theory and analytical methods found to be useful in the synthesis and analysis of systems."

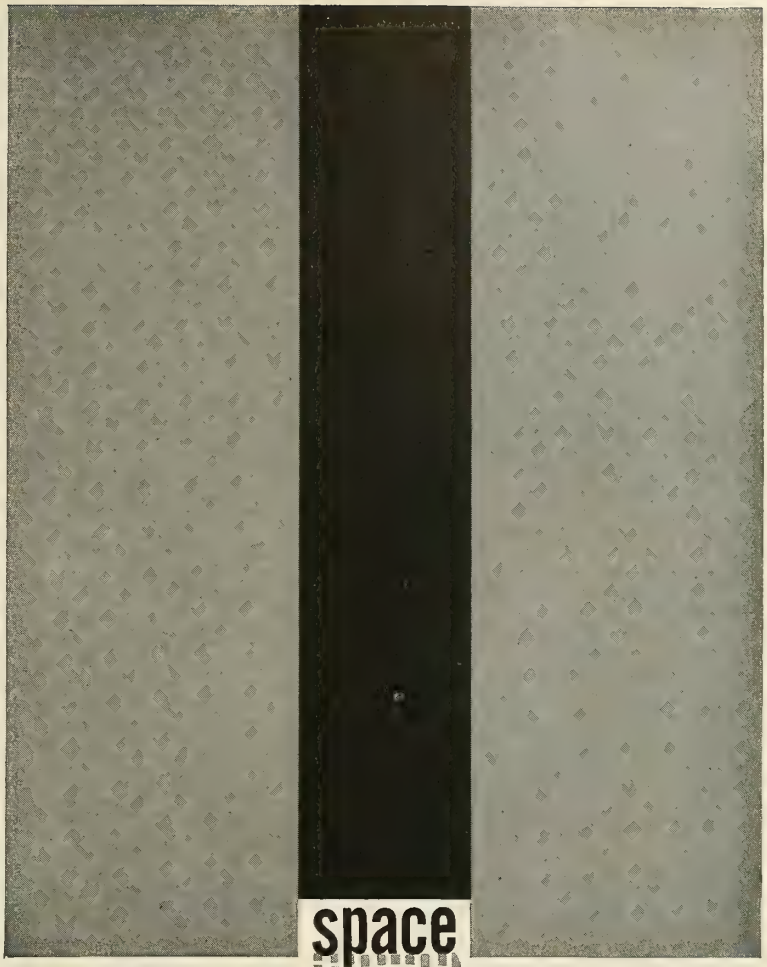
Special features: emphasis on nonstationary ensembles and time-varying linear systems; discussion of the adjoint method of statistical analysis for linear time-varying systems; detailed consideration of the problem of producing minimum mean-squared error at any time with nonstationary statistics; and treatment of generalized criteria and restricted choices, including multi-dimensional, nonlinear, boundary-valued, variational problems in optimal synthesis.

METHODS OF CELESTIAL MECHANICS, Dirk Brouwer and Gerald M. Clemence, Academic Press, New York, 598 pp., $15.50.

Here is an excellent, easily understandable text for the calculus-equipped engineer or scientists willing to invest some time in reading the material. The volume is directed to the man having a practical need for the information. The authors are well qualified: Brouwer is Director of the Observatory of Yale University, and Clemence is Scientific Director of the United States Naval Observatory.

A reader finishing the book will have a comprehensive background in celestial mechanics. From the immediate practical viewpoint, the presentation and arrangement of material have been designed to facilitate numerical work.

Topics covered include elliptic motion, expansions in elliptic motion, gravitational attraction between bodies of finite dimensions, calculus of finite differences, numerical integration of orbits, aberration, comparison of observation and theory, method of least squares, differential correction of orbits, general integrals, variation of arbitrary constants, lunar theory, perturbations of the coordinates, Hansen's methods, the disturbing function, secular perturbations and canonical variables.



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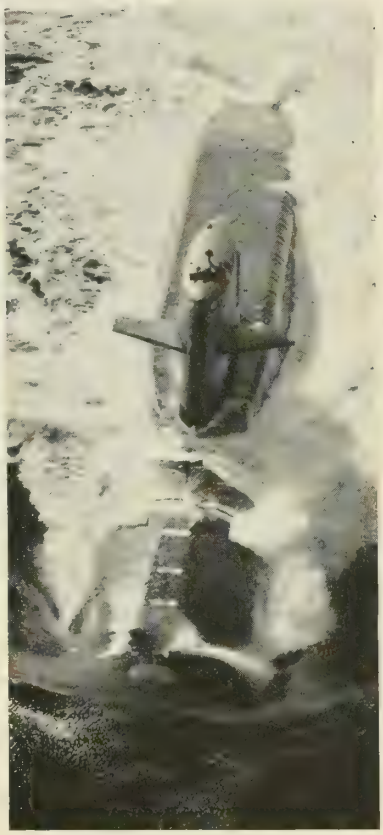
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The Countdown

WASHINGTON

RIFT Contract Announcement Due

NASA is expected to announce the winner of the *RIFT* (reactor in flight test) contract this week. Marshall Space Flight Center sent its evaluation of the proposals by the three competing firms—Martin, Lockheed and General Dynamics/Astronautics—to Washington on May 6 without recommendation. Implication is that final decision at NASA headquarters will be based on political and economic factors.

MMRBM Proposals Due Soon

Bids on the Air Force's *Mobile Medium Range Ballistic Missile (MMRBM)* are due on May 21. Three contracts are expected to be let: for the re-entry vehicle, land vehicle and the missile.

Lewis to Handle Apollo Lunar Module

NASA's Manned Spacecraft Center at Houston is tentatively planning to "subcontract" the lunar landing module for *Apollo* to the Lewis Research Center. Lewis would act in much the same capacity as MIT has on guidance.

Minor Opposition to ComSat Bill

Despite threats of some senators to filibuster the communications satellite bill to death, Administration officials are confident it will pass. They estimate the opposition has only 12 votes—far short of the 51 needed to kill it. The Senate Commerce Committee is expected to approve the legislation this week. The House already has voted approval by a thumping 354 to 9 vote. It probably will be six months to a year after enactment into law before the corporation can begin operation.

Senate Hearing Next Month on NASA Bill

Public hearings on NASA's Fiscal 1963 authorization bill are expected to open before the Senate Space Committee early next month. The *Centaur* program will receive close attention. Final action on the bill by the House Space Committee was due late last week.

Defender Research Program Expanded

APRA is expanding its ballistic missile research program to include a significant number of satellite-borne measurements of ICBM's during launch phase. Known as TABSTONE, the program has been in existence since the spring of 1961. Until now, measurements have been carried out by aircraft and by rocket probes.

Mauler Development to be Speeded

Funds in the Army's FY '63 budget will be used to accelerate development of the GD/Pomona *Mauler* air defense weapon system. The Army, pleased with progress of the system, expects to complete the major portion of R&D during the next fiscal year.

Reorientation for Advent Program

Centaur troubles are forcing a re-examination of the Army's *Advent* communications satellite program. Funded at $100 million in FY '63, *Advent* originally was scheduled for seven launches during the next fiscal year. Army officials say *Centaur* problems plus a DOD requirement to make the system compatible with NASA's *Syncom* have forced re-orientation of the entire program.

INDUSTRY

New Facilities for California Town

North American Aviation is planning a $7½-million plant at Seal Beach, Calif., for production of the *Saturn S-II* stage. Douglas Aircraft is planning a space science center nearby which will include a Douglas-funded space chamber large enough to handle an entire engine section of the *Saturn S-IVB* stage.

Douglas Building Own Saturn Transporters

Huge transporters designed and built by Douglas Aircraft for the *S-IV Saturn* stage use a new high-strength structural steel alloy developed by U.S. Steel. Transporters will be employed to carry the *Saturn* stages between production and test sites and the barges planned for long-distance transport.

Goodyear Makes a Blimp Pitch

Hoping to interest Chrysler officials in the possibility of transporting the *Saturn* first stage by air, Goodyear sent its blimp to the Michoud plant for a demonstration en route to the Seattle Fair.

INTERNATIONAL

Blue Water May Be Scrubbed

Reports from England that the *Blue Water* missile may be scrapped have boosted chances of the Sperry *Sergeant* in the competition for a short-range NATO ballistic weapon.

Germany Studying Nuclear Missile

Boelkow Entwicklungen of Munich is reported to have completed a secret feasibility study of a mobile 1500-mi.-range ballistic missile with a nuclear warhead. The study was undertaken at the request of the West German Defense Ministry.

Aerojet Moves Into Canada

Canadian Bristol-Aerojet Ltd., a jointly-owned subsidiary formed by Aerojet-General and Bristol Aeroplane Co. of Canada for production of solid-propellant rockets, will break ground next month for a $2-million plant outside Winnipeg.



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The Missile/Space Week

Marshall Study Contracts

The Marshall Space Flight Center has selected four missile/space firms to perform study contracts of future launch vehicles and space flight systems.

The "sole source" selections are part of a package of nine study contracts which Marshall is expected to award in the next six weeks.

The four firms are the Boeing Co., North American Aviation Inc., Lockheed Aircraft Corp., and The Rand Corp.

Boeing will conduct a *Nova* Solid Propellant Vehicle Preliminary Design study.

Boeing and North American are to make studies of a Reusable Ground Launch vehicle in the 50-to-100-ton orbital payload class. The study will determine conditions under which conversion to reusable configurations will be advantageous, and define configurations best suited to succeed the *Saturn C-5* orbital launching.

The Rand Corp. was selected to study and predict the desirable and attainable characteristics of space vehicles powered by electric propulsion.

Lockheed will study a Planetary Trajectory Manual which will provide technical information on planetary mission trajectories.

Other contracts and the firms competing for them:

• Post *Nova* Launch Vehicle study—A review of the state of the art for large launch vehicles available in 1972 or later.

Two contractors to make parallel studies will be picked from among Douglas, Lockheed, North American, General Dynamics/Astronautics, and Space Technology Labs.

• Early Manned Planetary Mission—A mission analysis of an early manned mission to the planets will be conducted.

Eight proposals have been received—from United Aircraft, Martin Marietta, General Electric, STL, General Dynamics/Astronautics, Ford Aeronutronic, Lockheed, and North American.

• Conceptual Design Study of Reusable 10-ton orbital carrier vehicle—Ten firms (names not available) are competing for this contract to develop design approaches and operational concepts for large-scale transportation and personnel in support of manned space stations, lunar bases and manned planetary expeditions.

• Study of the Application of Solid Propellant Motors to Future *Saturn C-1* class vehicles—This will assist NASA in determining if substantial gains can be attained in the *C-1*'s performance, cost reduction, reliability and operational considerations by replacing the first stage with a booster composed of solid propellant motors. Names of competing firms were not available, but award of the contract is imminent.

• Advanced Lunar Transportation Systems Study—This will investigate and compare two possible approaches for one or more follow-on lunar transportation systems using the *Saturn C-5* launch vehicle and nuclear propulsion. Ten firms are competing for the award.

Shots of the Week

The spectacular explosion of the $4-million *Atlas-Centaur* at Cape Canaveral on May 8 seemingly was caused by a malfunction in the *Centaur* stage itself, according to a preliminary analysis by NASA engineers. (See p. 13.)

• A nuclear-tipped *Polaris* missile was successfully launched from underwater by the submarine Ethan Allen May 6 and detonated in the Christmas Island test area, marking the first operational test of the warhead. The 1200-mile missile reportedly impacted within less than a mile of its target. The explosion was the fifth in the current series of U.S. atmospheric nuclear tests, and the first in which a live nuclear warhead was carried to target in a U.S. long-range missile.

• Failure in the second stage of the Army's usually reliable *Pershing* missile resulted in an abort during a short-range test flight at Cape Canaveral on May 9, putting the box score at 30 successes and 6 failures.

• Following NASA pilot Joe Walker's *X-15* flight of April 15, Air Force Major Bob Rushworth on May 8 streaked the same craft at 3511 miles an hour across the desert area near Edwards AFB, Calif. Rocket-powered for 103 seconds, the craft leveled off at about 73,000 ft.; temperatures at the plane's tail surface were reported to have possibly reached 1250°F.

• A *Nike-Zeus* launched from underground at White Sands Missile

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Range, N.M., successfully intercepted an electronically simulated target during an April 30 test of the anti-missile missile.

• A *Titan I* fired on a 5000-mile flight down the Pacific Missile Range May 4 marked the one-hundredth missile fired from Vandenberg AFB, Calif.

• On May 3 a *Polaris* missile left a fixed launching pad at Cape Canaveral and soared over the Atlantic missile range, the second stage and dummy warhead splashing someplace in the ocean.

Boeing May Get Saturn Job

NASA is considering selection of an integration and test contractor for *Advanced Saturn,* but the decision is about a year away, says Administrator James E. Webb.

During a Seattle news conference, at the NASA-sponsored Conference on Peaceful Uses of Space, Webb indicated that Boeing Co. is being considered for the job. He added, however, that it is too early to tell exactly what the requirements would be or who might be a logical contractor.

Webb, who visited the Michoud *Saturn* assembly center May 8, said the Boeing portion of the *Advanced Saturn,* the S-1C, is expected to cost about $300 million, with work running through 1966. He was quick to

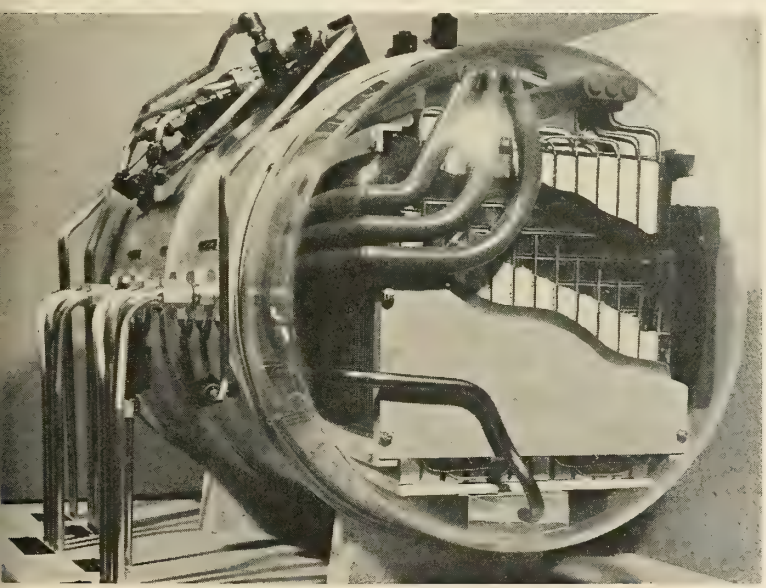
The *Advanced Saturn* is expected to have a useful life of about 10 years, Dr. Wernher von Braun, head of Marshall Space Flight Center, told the press conference. He said the vehicle might be used in the future as a one-way cargo carrier and a logistics carrier for orbital or planetary missions. It will not be manrated until about 1967, he said.

Esenwein Vacates Top AIA Office

A severe respiratory ailment forced August Esenwein to resign his position as president and member of board of governors of the Aerospace Industries Association. He will continue on a consultant basis after his departure on May 15. The AIA is considering a list of possible successors, but no sense of urgency is evident.

NASA Information Center

Documentation Inc. signed a $1.2-million contract with NASA to operate a completely integrated technical information center for one year. The center will disseminate space data to NASA, its prime contractors and designated organizations and individuals throughout the free world. The automated facility will use the latest in information retrieval, communications and data acquisition equipment. The facility will be located in Bethesda, Md.



GE To Build Gemini Fuel Cell

AN ION-EXCHANGE membrane fuel cell capable of 2kw peak loads will be built by General Electric's Direct Energy Conversion Operation for McDonnell Aircraft's Gemini spacecraft, under a contract estimated at $8 million (M/R, April 9, p. 24). Cryogenic oxygen and hydrogen will be used. The unit will provide a pint of water per kw-hour. The cutaway model above reportedly represents the fuel-cell type involved.

Questions and Answers about the

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UTC Wins the 120-in. Contest

Years of preparation in solids earn selection for job that will be worth estimated $73 million in first year alone

UNITED TECHNOLOGY Corp. will develop and build the 120-in., million-lb.-thrust, segmented solid engines for the *Titan III* booster—a program estimated to involve the spending of about $73 million in Fiscal 1963 alone.

The Air Force selected the United Aircraft Corp. subsidiary from a field of competing contractors including Aerojet, Thiokol and Lockheed Propulsion. No contract will be signed until the entire first phase of the *Titan III* program is approved by the Department of Defense (see page 35).

The selection capped the hottest contest this year and paved the way for proposal requests—expectable within 30 days—on larger solid concepts. These will probably be the 156- and 240-in. boosters.

The UTC *Titan III* strap-on solids will have four segments in addition to the fore and aft closures. But there is a potential for a fifth segment. Best guess is that the development program calls for 19 motors, three of which will be five-segment units. Liquid injection thrust vector control is called for in the contract for all motors, and UTC will have the responsibility for all ground support equipment involved in the program. This probably extends to launch operations.

• **Contract not final** — Since the contract has not yet been negotiated, a number of details have not been officially defined. It is expected that the 120-in. engines will be processed at UTC's sprawling Development Center near Morgan Hill, Calif.

The 5100-acre site can handle motor segments containing up to 150,000 lbs. of propellant each. Test stands are rated at 2 million lbs. thrust and the facilities include a solid processing and motor loading plant.

Again there are no definite figures, but the current UTC employment is around 800 with about 60% of these in the technical and professional areas. One California Congressman predicts a ten-fold increase in UTC employment as a result of the contract.

With well over $30 million of corporate funds invested in facilities and brainpower, UTC is probably still in the running for the larger solids study contracts due to come out. The 120-in. strap-on booster is currently tied to the Martin Co.'s *Titan III*, and this booster has been billed as a ten-year buy-out program. This may have some effect on UTC's standing as far as the larger solids are concerned.

Motor case fabrication for the 120-in. will be subcontracted by UTC. Previous cases for the current big booster test firings have come from Pratt & Whitney, but there is some feeling that development and production cases will involve other sources.

The nozzles will also be on subcontract. This is probably part of the original proposal submitted by UTC, since liquid injection thrust vector controls are required for the engines.

The five-segment motor would be more than 75 ft. in length. Four segments will have a total of about 500,000 lbs. of propellant and generate 1-million-lbs. of thrust.

• **Single-minded effort**—Besides being the opening gun in the push for big solids, the 120-in. program is UTC's first major contract since the formation of the firm in 1958. From the very beginning, UTC had its eye on big solids.

In four years, through deliberate planning and expenditures, United Aircraft built UTC into a major contender in the solid motor market. The firm planned and built its integrated development center in 12 short months, concurrently working out the concept of the segmented rocket.

The major effort has been directed towards solids. Fairly extensive development work has gone into hybrid rockets, however, and this is expected to continue.

Storable liquid space engines are also under investigation. An "atomizer" concept for these small units has been formulated to provide reliable directional thrust for space vehicles.

Ablation-cooled thrust chambers have been developed and supported under contract. Filament-wound, segmented motor cases is another field of endeavor. In this area, the firm has met with marked success, including the firing of the first glass-wound segmented motor. The concept involved can be applied to the largest solids currently under consideration. This work alone has earned the respect of at least one giant in the glass fiber industry.

UTC has five basic operating divisions:

—*Research*—Handles all basic and applied work essential to the "product line" of the corporation while taking on outside contracts in competent areas.

—*Engineering*—Another service division with essentially the same job as the research division in its own field.

—*Operations*—Performs and manages fabrication, processing, assembly and testing operations for all the firm's activities.

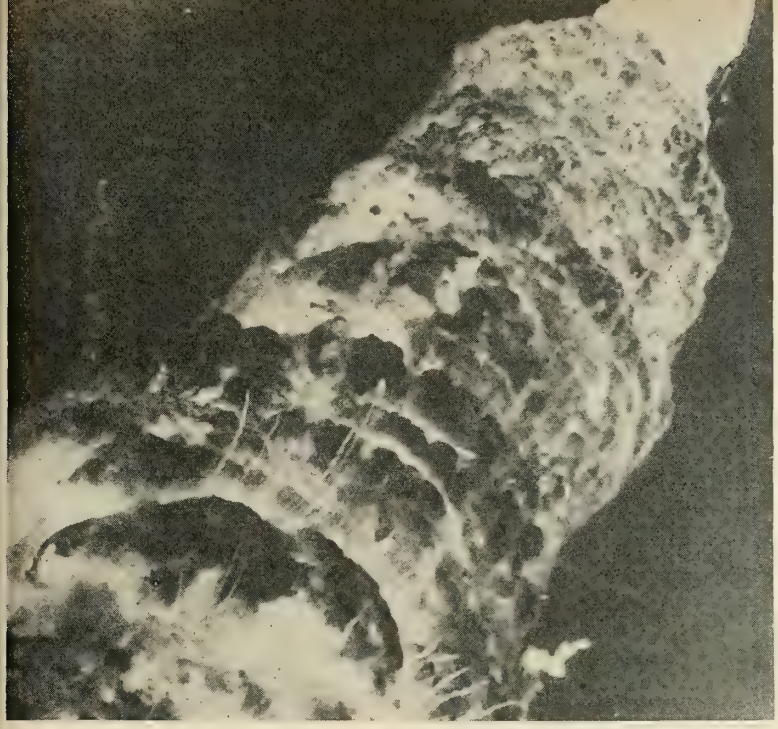
—*Space Boosters*—Handles project management functions on all large motor and component programs under development and production contracts.

—*Marketing* — Provides technical sales and service liaison with customers.

The extent to which specific project groups become autonomous under this system of management depends on the particular program under consideration.

There has been no indication of any corporate realignment within UTC to run the 120-in. program, but this may also be pending until the final contract negotiations are completed.

The competition for this contract was extremely active and observers feel that the choice was difficult to make. Technical capabilities, pricing and other factors were reported to be close. In any case, the selection set the stage for the next round—elbowing big solid boosters into the U.S. space program. ⌘



Centaur Faces Probe By House Group

ATLAS-CENTAUR disintegrates 54 sec. after launching on May 8.

by Hal Taylor

A HOUSE SPACE Subcommittee has ordered an investigation of NASA's long-delayed *Centaur* launch vehicle program.

The probe—precipitated by *Centaur's* unsuccessful first test flight on May 8—will be directed at the program's management, according to Rep. Joseph Karth (D-Minn.), Chairman of the Subcommittee on Advanced Research and Technology.

Centaur's first launch failed when a still undetermined malfunction in the liquid hydrogen-powered upper stage caused an explosion.

Failure of the shot put *Centaur* 15 months behind schedule, dealt a sharp blow to the U.S. manned lunar landing launch vehicle program, and made it almost certain that DOD's *Advent* communication satellite and NASA's *Mariner R* spacecraft programs will slip into 1964.

Karth declared that he intends to call witnesses from NASA, the Air Force and General Dynamics/Astronautics to determine why the program is behind schedule and what can be done to speed it up.

"We believe it has been poor management practices," Karth said.

The subcommittee had scheduled an investigation earlier this year. It was canceled, however, when NASA officials assured members that the "problems" have been overcome. Members of the subcommittee charged at that time that *Centaur* had been developed as "sort of a makeshift device" without proper systems engineering.

While Karth indicated that the industrial contractor will be subjected to strong questioning, NASA is also expected to get a real going-over.

• **Schedule is target** — One area which will get deep scrutiny is NASA's development test flight schedule.

The second *Centaur* launch is now slated to go next October, five months after the first failure.

Another shot is scheduled for December, but NASA officials admit that it is unlikely that it will be made until early next year.

The 1963 schedule is even more unrealistic, according to officials.

The space agency intends to make the last seven development flights next year at approximate six-week intervals. The schedule was based on the premise that a second *Centaur* launch pad would be available at Cape Canaveral.

NASA officials now report that the pad will not be ready until late next year.

The last three launches in 1963 were the first shots planned to boost payloads into orbit.

The payloads include two *Advent* and one *Mariner R* mission. Under NASA's original plans, they were scheduled for late 1962. With NASA officials admitting that the *Centaur* launch schedule is unrealistic, those programs are almost certain to slip into 1964.

• **Pad time**—Committee members may also want to inquire as to why NASA used an *Atlas* booster which had been standing on the pad for over a year for such an important launch in the U.S. space program.

The booster arrived at Cape Canaveral and was placed on its pad in February, 1961. Because of the delays in the *Centaur* program it was not mated to its upper-stage payload until last October. Beginning in March, 1962, five attempts to launch were aborted because of technical and weather problems.

During each attempt, propellant was loaded into the booster, only to be removed as each attempt was scrubbed.

NASA officials refuse to say whether they feel the long pad time contributed to the failure.

Space agency officials said the *Atlas* first stage broke apart 54 seconds after launch at an altitude of 25,000 ft.

The officials said preliminary data indicated that the malfunction occurred in the *Centaur* stage. They pinpointed the area of the failure as between the *Atlas* nose cone and the *Centaur*. NASA said a detailed analysis would be needed to determine the exact cause.

NASA officials continued to express confidence in the ultimate success of the program. They pointed out that there was no indication that a structural problem in the vehicle cause the explosion. Instead, they said, it appears to be a "small minor problem in some component."

The officials did rule out the possibility that the weight of the *Centaur* stage forced the explosion. If this had occurred, they said, the explosion would probably have taken place at maximum Q, about 74 seconds after launch.

• **Proof still lacking**—Besides de-

(Continued on page 38)

MA-7 Success Might Bring Series Near End

NASA considers planning seven-orbit MA-8 trip this summer; Carpenter slated to perform some new experiments

MA-8 MAY BE THE LAST of Project *Mercury's* three-orbit manned space flight missions.

Walter C. Williams, the Project's Assistant Director, told MISSILES AND ROCKETS that "further flights will depend upon the success of this week's *(MA-7)* mission with Astronaut Scott Carpenter at the controls."

This indicates that additional flights will be made only if *MA-8* is unsuccessful.

It is known, however, that NASA has planned at least one more three-orbit mission.

Recently, NASA's Office of Manned Space Flight and the Manned Spacecraft Center have studied a possible seven-orbit mission for the *MA-8* flight in August or September.

Robert Gilruth, Director of the Center, told M/R that the plan has no status at the "present time."

Other officials indicated that a decision on the longer mission may be made following the Carpenter flight.

• **New twists**—*MA-7* will be similar to America's first orbital manned space flight by Astronaut John Glenn last Feb. 20. It is scheduled for no earlier than May 17, and further slippage to next week is possible.



MA-7 Astronaut Scott Carpenter has gloves fitted prior to recent simulated flight.

The *Mercury* spacecraft will orbit at an altitude of approximately 90 miles. If all goes well, the flight will last about 4½ hours.

Carpenter, however is scheduled to perform a series of navigational and visual tests which will shed new light on man's capability in space and his ability to judge distances and perform orbital rendezvous.

The experiments include:

—Carpenter will perform more complete turn-arounds of the space capsule.

—He will also shut the control system down, permit the capsule to drift and then bring it back to the proper attitude.

Williams also said that Carpenter will track for as long as possible the *Atlas* booster which will put him into space. He will also attempt to plot navigation by the stars, and try to learn how the Earth's horizon can be used to determine position and course.

A transparent plastic tank of colored water will be installed in the capsule. Photographs will be taken to find out how liquids react to periods of weightlessness. The study will attempt to discover where the air goes and where the water goes as an aid to the design of fuel tanks for future spacecraft.

A multi-colored balloon will be deployed from the neck of the capsule while it is in flight. This will be used for color perception tests and drag measurements by the astronaut. Later in the flight, it will be released and an attempt made to get some idea of how far the astronaut can keep it in sight.

Carpenter will also use a hand camera in an effort to get pictures of the greenish, luminscent "fireflies" that Glenn saw through the window of his spaceship.

Last Apollo Guidance Contractors Named

NASA HAS COMPLETED its *Apollo* guidance system industrial team with the award of production contracts to three electronics firms.

A top space agency official said that the contractors—A.C. Spark Plug Division of General Motors Corp., Raytheon Co., and Kollsman Instrument Corp.—will serve throughout the *Apollo* Lunar Landing program.

"No more firms will be selected," he declared, "unless we find that we need a technical capability these firms do not have." At this point, he added, "it appears unlikely."

Total value of the three contracts was estimated at $20 million. A.C. Spark Plug received the lion's share of the production work, with a total award of $16 million. Both the Raytheon and Kollsman contracts were estimated at $2 million each.

The current contracts, however, cover only the Earth-orbital phase of the *Apollo* program. Other contracts to be awarded to the firms later will cover the circumlunar and lunar landing missions.

The follow-on awards, the officials said, will bring the total cost of the industrial portion of the guidance system development to about $80 million.

Massachusetts Institute of Technology (MIT) has already been awarded a $20-million contract to develop several guidance and navigation systems for the *Apollo* contract. In addition, MIT's Instrumentation Laboratory will serve as technical director of the industrial work in which the three firms will build 10 flight units.

• **Assignments** — A.C. Spark Plug will fabricate the inertial platform and its associated electronics. In addition, it will develop and build guidance ground support and checkout system and assemble and test all components of the system. The engineering and design portion of the contract will be performed at Wakefield, Mass., with production being accomplished at the Milwaukee plant.

Raytheon will manufacture the guidance system's on-board digital computer. Kollsman will build the optical subsystems—including a space sextant, sunfinders and navigation display equipment.

Earlier, NASA selected A.C. Spark Plug to build the gyros for the guidance system and Sperry Rand Corp. to develop its accelerometers. ⠿

Seeking unity with management . . .

Labor Proposes Federal Safeguards

ATLANTIC CITY, N.J.—Another crucial test of economic philosophies is shaping up for the government—this time with representatives of nearly 400,000 aerospace industry workers.

Though direct labor-management negotiations are already under way at two major aerospace firms—North American Aviation and Douglas Aircraft Co. —it is clearly the Federal Government, as the big spender in the business, that labor is shooting at.

At the recent United Auto Workers constitutional convention here, the UAW, which represents about one-third of the predominately blue-collar union force, passed a sharply-worded resolution calling for vast improvements in job security, layoff protection, insurance coverages, wage equities, and union representation for defense workers.

The resolution was developed jointly by the UAW and the International Association of Machinists (IAM) which represents the remaining two-thirds of the aerospace workers. Though IAM and UAW negotiate independently, they are in full consultation and this year are again acting jointly to push their demands and gain greater union stability within the industry.

In most cases, the UAW resolution puts squarely up to the government the responsibility for providing for workers who are largely at the mercy of the Defense Department.

Leonard Woodcock, UAW Vice President and chief negotiator for the aerospace labor group, told MISSILES AND ROCKETS that it would be impossible for any individual company to finance the type of layoff protection the union is seeking. What he hopes is that the union and individual companies can agree on suitable plans and financing for an emergency such as sudden cancellation of a large weapons system, and present a unified program which the Government would then agree to underwrite.

Woodcock said the aerospace workers have a lot of catching up to do. He believes they have been victimized by lower straight-time wages and far fewer fringe benefits than are enjoyed by workers in other fields, as well as those doing similar jobs but belonging to parent companies in another industry. As an example, he cited workers for the AC Spark Plug Div. of General Motors, where many perform the same jobs as aerospace industry people but reap higher hourly pay and other sophisticated benefits granted by the motor industry.

• **Labor's demands** — Briefly, here is what labor wants and the order in which labor leaders will emphasize it.

—*Job Security* — Coordinated procurement by both industry and government, for a more even work flow and sufficient advance notice on contract cancellations.

A layoff benefit plan along the lines of the supplemental unemployment (SUB) and separation pay plans now common in other industries.

Government reimbursement to each company for layoff payments, or government insurance for an industry-wide income security fund.

—*Wages*—Catch-up raises to bring aerospace rates up to comparable industry levels.

Annual raises based on overall productivity.

More meaningful cost-of-living clauses.

Fair differential for work on off-base sites, and clarification of overlapping job classifications.

—*Insurance*—Vastly improved plans fully paid by management for all employees and their families including full-year hospital benefits, full-cost surgeon fees, weekly sickness/accident protection equal to 2/3 income for 26 weeks, life insurance equal to one year's earnings, and health insurance coverage extended to those disabled, laid-off, or retired.

—*Union Shop*—Establishment of a union shop in all aerospace plants. Only a third of the firms within the industry have this, according to the union.

Restrictions against subcontracting and other forms of diverting work normally done by IAM and UAW members.

• **Costs hard to define** — Just how much all this will cost is hard to say at this point.

There will be no flat across-the-board wage demands for various classifications of workers. Woodcock points out that demands will vary from company to company depending on the going local rates, and that in many cases settlements may differ within various plants of the same firm.

The best guess is that wage demands will be pushed in most cases to levels nearer those in the auto industry, and in a very few instances perhaps towards steel wages. Woodcock reports that current hourly straight-time rates in the aerospace business average $2.70, as opposed to $2.85 in auto and $3.18 in steel. This would give a spread of between 19 and 48 cents hourly, heavily weighted towards the lower figure.

In UAW President Walter Reuther's report to the convention, he asserts that since 1960 leading employers in other major industries have increased take-home wages from 19 to 23 cents an hour. He contrasts this with 11 to 14-cent increases for the aerospace industry.

For the other programs, a sizeable chunk of the cost for the heavy layoff protection could be swallowed by the Government—if it agreed to underwrite a joint labor-management plan in this area.

Contributions by aerospace companies to employee insurance plans, according to the union report, are limited to 3.1 to 5.6 cents an hour, as opposed to other major industries where the union reports employers contribute 15 to 18 cents an hour to comprehensive programs.

Woodcock, in defending the wage demands along with the fringe benefits, assert that he "has urged our people to take as a standard what already exists. We are not asking them for something new. We merely want what has been already sanctioned in other industries."

• **Moot details** — Woodcock says that while he is confident that unions can agree to a non-inflationary settlement within the broad "guidelines" set down by the Kennedy Administration, he is in open disagreement with some of the program details.

In particular, he does not agree with the annual 3% productivity-wage increments recommended by the Council of Economic Advisors. Woodcock feels this is setting the sights too low in general, and the rate is neither adequate nor equitable for the aerospace workers. "If you raise the steel workers pay by 3%, it is not enough to raise the lagging aerospace workers 3%."

Woodcock also says the traditional arguments in labor-management negotiations have to be put aside with the aerospace industry, because of the al-

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New Theories Liven Last COSPAR Sessions

Scientists downgrade Lovell's fears for radiation belts; new data on ultaviolet emissions reopens old questions

by William Beller

DURING THE CLOSING sessions of the Committee on Space Research (COSPAR) last week, delegates heard disparagement of a new concept of a well-known British scientist, a forecast of a revolution in astrophysics, a hypothesis of a hydrogen-helium atmosphere for the moon, and a new description of Venus—somewhat cooler but still inhospitable.

These sessions followed earlier ones during which the U.S. and Soviet outlined their plans for space research during 1962, and Lt. Col. John H. Glenn and Major Gherman S. Titov gave papers on the operational aspects of their space flights (M/R, May 7, p. 12).

• **Belts' integrity** — Several prominent COSPAR scientists pooh-poohed the idea recently put forward by Sir Bernard Lovell, director of Britain's Jodrell Bank radio-telescope station, that high-altitude nuclear explosions might twist the Earth's radiation belts out of shape for the next decade. The most the scientists would admit was that the explosions could put some wiggles in the Earth's magnetic field; but they declared that the effects would be short-lived—measured in days or weeks at the most—and the belts would soon be as good as new.

They backed their thesis with observations made of the effects of solar flares: James Milligan and Theodore Stecher of Goddard Space Flight Center reported that during November, 1960, solar events they observed an extremely bright background in the sky at about 1300 Angstroms, which had no visible counterpart.

It was generally concluded that this unexpected phenomenon was a "dumping" of the Van Allen belt as a result of the solar flares. And it was further pointed out that the belt was quickly replenished.

• **Revolution in astronomy** — Discoveries this past year about ultraviolet emissions from "hot" stars are bringing in their wake a revolution in astrophysics comparable to the one brought about by radio astronomy shortly after World War II.

Until the recent past, astronomers derived their theories of the universe from data extrapolated from observations made in the visible spectrum. The first shock came when radio astronomy—and now ultraviolet astronomy—began showing that some of these extrapolations are not valid.

As a result, basic questions are again being asked about the physics of stars and of the interstellar medium—questions that astronomers felt they had at least partially answered.

The most recently noted anomaly is that the ultraviolet radiation coming from "B" or hot stars is sharply cut off below wavelengths of about 2400 angstroms. Astronomers say that this is not what theory predicts and will call for a wholesale revision in stellar astronomy.

Another anomaly sparking the revolution stems from an earlier rocket experiment by the Naval Research Laboratory in which researchers found nebulosities in front of hot stars so bright in the ultraviolet they almost masked the stars completely. Here, too, theory based on "visible" data fell short in predicting the appearance or cause of the phenomenon.

To discuss explanations of the anomalies, four prominent astrophysicists addressed a press conference. But the only point they agreed on was that explanations are due—and that possibly more data will be needed before a consistent astrophysical model can be erected.

These scientists—Douglas Heddle, University College of London; James Milligan and Theodore Stecher; and Jean Pecker, Observatoire de Paris—suggested three possibilities. Only Dr. Pecker, however, would go on record: he hypothesized dust particles around the hot stars which absorb the lower wave-lengths of ultraviolet.

Another possibility is that some mechanism interior to the stars keeps the low-end ultraviolet from getting out, or that a better model of the hot stars will explain everything.

The speakers anticipated that much light will be shed on the subject by the prospective *Orbiting Astronomical Observatories*.

• **Moon and its atmosphere**—The moon was pictured as having a tenuous hydrogen-helium atmosphere together with a lopsided magnetic field.

Hydrogen streaming from the sun reaches the surface of the moon, re-evaporates and comes off the surface at a speed less than approach speed—and therefore with a much higher density, according to Cornell scientist Thomas Gold.

Through this mechanism, Gold envisions the moon having a "temporary" hydrogen atmosphere with a density of approximately 10,000 atoms/cu. cm. to 20,000 atoms/cu. cm. Similarly, the moon would gain a helium atmosphere, Gold says.

The material streaming from the sun would bring a magnetic field with it; and Gold sees this field pressed into the front face of the moon and built up until finally the incoming field is rejected by the field already present.

Thus, the scientist sees the front or

(Continued on page 37)

Sharing Informatio

AT A PRESS conference following the COSPAR meeting a number of questions were addressed to Maj. Titov concerning the configuration, staging and other details of his space ship. This is a partial transcript of his answer and Col. Glenn's subsequent remarks:

TITOV: I answered this question several times and if you put this question still then I'll answer once more. Have you read the recent message of Mr. Khrushchev to the President of the U.S.A., Kennedy? It is clearly stated there, and Colonel Glenn will approve, that the cosmic ships are boosted into space by means of military rockets.

Nowadays super-heavy ships are boosted into space by more

U.S., Reds Share View of Space Nausea

Glenn and Titov deliver accounts of their flights; other reports cover radiation, exobiology

by Heather M. David

THE USSR apparently is pursuing the same line of research into the problem of Titov's "space sickness" as is the United States.

U.S. disorientation expert Dr. Ashton Graybiel (Capt. USN) told M/R that the Russian seem to have ruled out the idea that Titov's nausea was caused by some individual defect in his own vestibular mechanisms.

Like the U.S. scientists, the Soviets indicated that the clue to Titov's illness lies in the otolith apparatus, one of the two main organ systems in the inner ear (the other is the semicircular canals). The Russians also indicated that they believe that the nature of the otolith will probably cause the same symptoms in all astronauts who experience prolonged periods of weightlessness.

• **Titov report**—A highlight of the COSPAR meeting was the appearance of Maj. Gherman Titov and Col. John H. Glenn, both of whom presented reports on their trips into space.

Although little emerged new from these talks, Titov did say that his capsule contained a "regenerating plant substance"—which he implied was used for oxygen supply. However, he did not say that this was the main source of oxygen, and U.S. experts conjecture that it probably was an experimental prototype like those reportedly tested in some of the earlier animal capsules.

Nevertheless, a highly authoritative source reported that *Vostok I* was equipped with a 7800 psi oxygen system plus a back-up potassium super oxide regenerative system of 10 days' capacity. The back-up system was said to have worked so well that on *Vostok II* it became the primary system, and the 7800-psi system became the back-up.

He said that throughout his trip pressure was maintained at 740-750 mm. of mercury; temperature 25°C at beginning of flight, dropping and staying at 12-14°C. Content of oxygen was maintained at 25-27%, and carbon dioxide did not exceed 0.4%. Relative humidity was within 50-70% limits.

Results of previous Russian bioastronautic flights—*Sputniks II* through *V*—were discussed by V. V. Parin and O. G. Gazenko. They said that genetic changes had been found in onion and nygella seeds, resulting in more rapid growth than those control groups which had remained on Earth. Speeded-up growth also was observed in some plant sprouts and radiant fungi, which the Soviets said could not be attributed to radiation in flight. No further explanation was given.

Heart and respiration rates were given for the Gagarin and Titov flights. Parin said that 30 minutes before liftoff, Gagarin's heart rate was 66 beats per minute, and respiration 24 per minute. Three minutes before launch, pulse was 109 beats per minute, respiration was "smooth and calm." After liftoff, and during acceleration, pulse was 140-158 beats per minute, and respiration rate was 20-26. By end of the powered portion of the flight, pulse dropped to 109 beats, respiration to 18.

Titov's pulse before liftoff was 70 beats; five minutes before launch it was 105 beats. He said that it reached only 119 beats at the acceleration stage, and dropped to 104 beats while going into orbit, then to about 76 beats for the duration of the flight—except during sleep, when it was 54-56 beats. Titov said respiration rate varied from 18-22 breaths per minute.

• **Radiation**—A summary of radiation hazards was presented by Dr. Trutz Foelsche, of NASA Langley Research Center. Dr. Foelsche said that the radiation problem in space appears to be more serious than was suspected even five years ago. He pointed out that exact effects of the heavy primary component of the cosmic-ray beam are not known. However, he said that shielding in the order of 30 g/cm^2 of low Z number material would reduce the num-

(Continued on page 37)

he Viewpoints of Titov and Glenn

powerful rockets which—as compared to those which are used for military purposes. And in this message, it was stated that the sooner we come to an agreement in the question of disarmament the sooner we'll visit each other and the quicker and with pleasure I will fly together with Colonel Glenn into space.

And if you understood me correctly then you'll know the question of the questions is the question of armament, of disarmament.

GLENN: Just let me make one comment here, because we have a number of the foreign press who are here today, with comments on disarmament as a requirement for sharing information. And I make this only so that we set the record straight as far as we are concerned, too.

We share our information quite openly, as all of you are aware. The booklets we passed out today had very complete reporting. It's our opinion that we should not have to have disarmament before we share opinions like this. This is from this country, of course.

Our idea is that the sooner we can all share this, the sooner it may be the very—the very enjoyable fact—that Major Titov and I could make a space mission together. And I certainly look forward to that day. (End of transcript.)

But apparently Titov had a change of heart, for he said later that he really wouldn't want to take a space trip with Glenn because the U.S. has "too many failures."

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Technical Countdown

ADVANCED MATERIALS

Russians Improve Silicone Rubber

A method of bringing the thermal stability of polymeric materials to the theoretically possible limit is under development at the Institute of Chemical Physics of the Soviet Academy of Sciences. The procedure is based on the assumption that thermal, photochemical or radiation degradation of polymer radicals in combination with effective stabilizers would effect chain transfer—and the formation of new macromolecules from "secondary macroradicals," with fewer "weak bonds" in the polymer chain, upon recombination of the macroradicals after treatment. The hypothesis was checked out with polydimethylsiloxane in a vacuum at 150°C. After 20-30 hours, the Russians report, marked destruction and impaired hardness were observed—but after 60-70 hours, radical recombination and increased hardness and tensile strength developed. Analogous treatment at 200°, 250°, 300° and 350°C showed that the rate and degree of degradation, and correspondingly, the rate of radical recombination, increase with temperature. The material regained its rubber-like properties, including an elastic stretch of 80 to 100% upon continued heating.

Calibration of 10^{-9} Torr Gauges Now Possible

A four-stage vacuum gauge calibration unit has been developed by National Research Corp. to accurately handle ultrahigh vacuum ranges. The 10^{-9} torr gauge calibration system is divided into five chambers and has four pressure reduction stages. The first chamber uses a mechanical pump, the others involve diffusion pumps. A McLeod gauge is attached to the second chamber as a reference standard and the gauge to be calibrated fits in the fifth chamber. The system is based on the known pressure drops of gases through precisely machined orifices. The system provides accurate calibration at 50,000 times lower pressures than previously possible.

Ultrasonic Quench Strengthens Alloys

The Russians report they have successfully applied ultrasonic fields during quenching operations on a laboratory scale, increasing the hardenability of high-carbon steels. Ultrasonics were also applied to a liquid medium in case hardening, and the diffusion rates tripled while the depth of case doubled. Ultrasonic treatment coupled with heat treatment doubles or triples microhardness of aluminum and zinc parts. None of the reported methods are sufficiently developed for industrial application.

Titanium Grades Developed for Liquid Hydrogen

Extra-low interstital (ELI) grades of two stand-by titanium alloy compositions for use at liquid hydrogen temperatures have been perfected by Titanium Metals Corp. of America. In the control of interstitals, particular attention is given iron and oxygen contents—0.25% maximum in iron and 0.12% maximum in oxygen. This control improves the notch strength characteristics and permits retention of elongations 7 to 15%, even though the tensile and yield strengths actually double. The control also enhances rolling properties of titanium.

Explosive Techniques Perfected by NOL

A new experimental method to directly observe the behavior of explosive materials in the 300° to 1000°C range has been developed at the White Oak Naval Ordnance Laboratory. The technique evaluates the rate of decomposition of explosives at high temperatures, by confining the sample in hypodermic-type stainless tubing and maintaining a specific high temperature until exploding. The surface of the tube can be heated to this specific temperature in zero time; its significant temperature coefficient of resistance permits ready determination of its temperature at the time of explosion. NOL scientists say the situation corresponds closely to the ideal case of an infinite cylinder of explosive material at low temperature, the surface of which is heated to high temperatures in zero time until the explosion.

Weight Measurement Performance Specs Issued

A performance specification guide for weight measurement systems, regardless of type, has been issued by the Society of Aeronautical Weight Engineers, Inc. The specification guide attempts to define the parameters for a statement placing tolerances on a measurement system. While restricted in scope to weight and force measurement systems, the outlined principles are applicable to all types of measurements.

PROPULSION

Thrust Augmentation Experiment Planned in U.K.

A full-scale experiment into regaining the thrust lost through use of low-altitude nozzle expansion ratios is planned for the end of the year by British scientists. The *Black Knight* test vehicle would be used. The problem centers around the thrust lost by first-stage nozzles at high altitudes because of underexpansion. British space experts heard an interim report by D. J. Harper at the Second Rocket Propulsion Symposium last month. The augmentation approach will include suitable design of the propulsion bay geometry and, in the case of clustered motors, use of the interaction between jet effluxes at high altitudes to develop extra thrust acting on the base of the vehicle.

ELECTRONICS

Economical High-Resolution Antenna Proposed

A high-resolution antenna that can be built at a fraction of the cost of a comparable dish unit is under investigation at the Air Force Cambridge Research Labs. One such proposed antenna would have an effective aperture diameter of 2400 ft. yielding a beamwidth of 1 min. of arc at L band. It would consist of 7000 flat, 20-sq.-ft. plates arrayed in a giant clover leaf pattern. The plates of the "petals" would be arranged in concentric rows, and each would be oriented to redirect radiation from a particular direction of focus. It is possible to scan the antenna over a 90° cone—45° in all directions from the azimuth. Adjustability of the plates permits operation over a frequency range of 200 to 2000 MCPS with rapid and flexible beam steering. A model under construction at AFCRL's Strawberry Hill site will use 220 reflecting plates and a 100-ft. feed tower.



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Raytheon To Push for Space Dollars

Addition of Phillips to front office adds greatly to technical strength; first Apollo award won

by Michael Getler

LEXINGTON, MASS. — High on the "things to do today" list of Raytheon's new No. 2 man, 37-year-old Thomas L. Phillips, is a note to improve the company's share of the expanding space market.

Phillips told MISSILES AND ROCKETS he is pleased with the technical progress of the company, but not satisfied with the success ratio—in terms of bids submitted—on the nation's space programs.

Last year less than 1% of the firm's $562-million sales were in the space field. This year, Phillips says Raytheon will make a concerted effort to up the total.

The firm's first real space hardware breakthrough came last week on Project **Apollo.** NASA awarded Raytheon a contract valued at about $2 million for manufacturing the **Apollo** guidance system's on-board digital computer.

Phillips notes that the rendezvous radar concept included in North American's winning *Apollo* proposal was a Raytheon-designed FM/CW system. Though the radar award is expected to face strong competition for actual development and production contracts, this early recognition of Raytheon's capability in a traditionally strong area has given the company new confidence.

In the guidance field, Raytheon has already received about $15 million from the Navy for providing MIT with this type of effort on the *Polaris* Mark II guidance system. The *Apollo* guidance is said to contain many components similar to those of *Polaris*. Raytheon has been credited with developing several significant component packaging techniques which led to weight and power reductions in the *Polaris* system.

The company also is competing with RCA on another phase of *Apollo* —a TV display for exploration of the lunar surface. Raytheon is reportedly pursuing a reduced bandwidth digital design; RCA is said to be using analog techniques.

• **Phillips could be key**—If any one man is apt to change Raytheon's space picture dramatically, it may be Phillips. His enlistment as executive vice-president of the 43,000-employee firm represents the addition of something strangely absent from Raytheon's highest echelons for several years—a top missile/space-oriented engineer.

Phillips has been with Raytheon since 1948, and has considerable grass roots support within the divisions—in particular the Missile/Space Div., where he was vice-president and general manager .

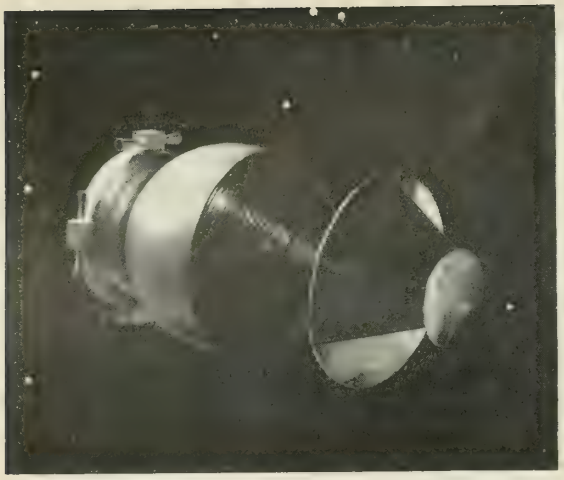
Just how much weight he will swing with the scientific types now so prevalent in NASA and DOD front offices is not yet known. He is sure to be able to present far more than just the management side of the picture.

Phillips took over his new duties at the beginning of this year, and though it is perhaps too early to trace his effect, Raytheon's first-quarter-of-'62 fiscal report, announced last month, was the most auspicious in some time.

Sales for the March quarter were highest in the company's history ($157.3 million) and the 1.6% profit margin was the best since the third quarter of '60. Like many others heavily steeped in defense contracting (83% of



THOMAS L. PHILLIPS, at 37, is No. 2 man in Raytheon's $600-million operation.



SATELLITE interceptor is now active Raytheon proposal.

'61 sales), Raytheon has been plagued by a low profit margin for many years. Phillips predicts that this figure will grow to about 2% by year's end.

It should be noted that though Phillips was in as exec-VP in December, company president Richard E. Krafve still stood between him and Board Chairman Charles F. Adams. Krafve, who was generally described as more commercially oriented, left the firm in February due to "policy differences" with top officials. This also left open the presidency: Adams, wearing two hats, now serves as president and as acting chairman of the board.

• **Hold the 80/20 line**—Though Phillips indicates no intention of altering the rough 80/20 split between Raytheon's government and commercial operations, his very presence in the new job may serve just that purpose.

If his heavy systems background does expand the company's technical base—and cause even more DOD dollars to flow to Lexington—the Commercial divisions may not be able to expand fast enough to keep pace.

These divisions, according to Raytheon officials, have done well to maintain the balance in recent years, especially in light of the tough semiconductors business.

In addition to the reported $562 million in '61, another $35 million was grossed last year in the firm's expanding overseas operations.

In addition to a group of European subsidiaries, five major component manufacturing firms abroad are now owned wholly or in part by Raytheon, among them recent acquisitions in Japan and India. Negotiations are also said to be under way for a South American acquisition. The low labor costs and new markets offered by operations, according to Phillips, have done much to improve the company's position overseas in the semiconductor field.

• **In on the big ones**—Phillips' ride to the top at Raytheon has been aboard the company's two biggest projects—the Army and Marine Corps' *Hawk* surface-to-air missile and the Navy's *Sparrow III* air-to-air system. The latter program, now in its eleventh year, has brought in some $400-500 million. *Hawk*, eight years old, is even larger.

Most of the *Hawk* R&D is about over, with the exception of some funding on improved high-power illuminators for the ground-based radar. However, production funds continue to roll in for *Hawk*. The missile is already prominent in the U.S. arsenal and a European-built version is about a year away from NATO deployment.

NATO *Hawk* has been a considerable success (M/R, Nov. 6, p. 12), and Phillips describes it as a small version of how a phase of the common market might work, with five highly competitive firms combining efforts to turn out the system. He reports Raytheon has been consulted on several occasions by other firms attempting to organize the same type of venture.

Raytheon's *Sparrow III*, already operational with the U.S. Fleet on the F3H aircraft, is currently riding high with McDonnell Aircraft's F4H Mach 2+ interceptor. The Navy is continuing R&D funding on an advanced version of *Sparrow III* with increased range, altitude, and ECM performance. Air Force purchase of the F4H (M/R, Jan. 15, p. 9) is also certain to up both R&D and production funding.

The missile has already been selected for secondary armament on the controversial tri-or-bi-service TFX; and Raytheon, along with Hughes, Bendix, and Grumman, has also bid on the aircraft's primary missile armament system.

Some recent reports out of Washington indicate the whole TFX program may be in trouble. If so, it has been further rumored that DOD may go to the F4H as the best available aircraft for the TFX role. This, of course, would up *Sparrow* stock even higher.

• **A-ICBM effort**—In addition to primes on *Sparrow* and *Hawk*, and the fire control subsystems on *Tarter*, *Mauler*, and *Shillelagh*, Raytheon is getting fairly deep into the A-ICBM business.

The ARPAT contract held by the firm, part of Advanced Research Projects Agency's Project Defender, is second only to *Nike-Zeus* in A-ICBM funding. Raytheon, teamed, with Hughes, Boeing, IBM, and Bissett-Berman Co., has already been awarded about $16 million in this program. If the system proves feasible, a production follow-on could run into hundreds of millions.

The three-phase program is actually a systems study based on a sophisticated enemy threat including decoys. A prototype target discrimination radar will be designed and built in addition to experimental versions of a small, lightweight dart-like missile capable of downing reentering ICBM's. The missile being studied has a non-nuclear warhead and is designed with a hit-to-kill philosophy. First flight tests of the missile, which will be launched from an aircraft during the trials, are said to be about a year away at White Sands.

Phillips reports the company is also getting sizeable chunks of business from various missile penetration aid programs, including *Minuteman*, *Polaris*, and a rocket device for the B-52. A big lingering question mark in Raytheon's missile future is the Army's decisionless *FABMDS* (Field Army Ballistic Missile Defense System) program, which came down the wire to a somewhat abrupt pause with GE and Raytheon said to be leading contenders.

• **Changes coming** — Phillips includes Raytheon in the same boat with many other aerospace firms in the military space market. "We are interested, and we are bidding, but to date only two or three firms have really hit big."

He is also well aware of changes facing his company and others in the same business. "We foresee a period, perhaps five years away, where production plants, in the light of heavy one-of-a-kind space requirements, will often be turned into R&D facilities." Right now, Phillips says, R&D is a vital but not especially profitable undertaking. This picture will have to change, he feels, if industry is to man large scientific teams; and, more importantly, he adds, if they are to keep these teams working together over long periods.

He views the movement towards incentive contracting by DOD as a good start in making it worthwhile for firms to engage heavily in R&D programs that offer little or no production follow-on. For the past three years, government R&D contracts with Raytheon have run to about $100 million annually. Company-funded R&D now stands at $13.6 million each year. ⌘

Compound Promises Wide Control Uses

by Frank G. McGuire

WILMINGTON, DEL. — A potential boon to control systems lies in a metallic compound with a programable profile of unique, abrupt changes in size and magnetic properties—changes brought about by varying temperature.

The material is being studied by the DuPont Company for control systems and other applications. First observed two years ago, it is described as a brittle gray compound called chromium manganese antimonide. Several other compounds exhibiting the same general properties have also been discovered.

Key to the unusual properties is the temperature of the material—at a precise point, selectable over a range of several hundred degrees, both the magnetic properties and the physical size undergo a sharp transition.

As the temperature drops below the transition point, the antimonide changes sharply from a ferromagnetic state to an antiferromagnetic state, and decreases in size by more than 0.2%.

Dr. William H. Cloud, of DuPont's Central Research Department, explained the properties and demonstrated test rigs showing the material used as a sensor in simulated control systems utilizing both magnetic properties and the physical size as the key parameter. Another test unit, using a radio receiver and transmitter to simulate a telemetry system, used the compound as the core of a wound coil controlling the frequency of a tone output from the transmitter. As heat was applied to the core, the tone broadcast by the receiver changed proportionately.

The point at which the transitions occur can be programed into a desired profile as the compound is being prepared for the particular application. A precise relationship between temperature and phenomena can be established by proper chemistry.

Dr. Cloud says the electrical conductivity of the material is also altered with temperature changes, and the transition point of the compound can be modified by applying a magnetic field. A change of 2000 gauss moves the transition point by one degree C.

• **Problems conquered** — Normal melting point of the compound is about 920°C, and some initial difficulty was encountered in formulation—but these problems have been overcome.

"The applications of this material will be unique, just as the compound itself is unique," Dr. Cloud said, "and there are probably just as many objections to its use as there are advantages. It won't necessarily replace any of the present materials, but we think it will certainly open up a lot of things that couldn't be done before."

As for space-system applications, he continued, the earth's magnetic field is far to weak too affect the material by changing its transition point.

According to DuPont, the antimonide was the first intermetallic compound to exhibit the characteristics, but several others have come along since then. Manganese antimonide is a normal ferromagnetic substance, but the addition of selected quantities of chromium is what causes the unusual properties.

• **Realignment key**—The transition, called "exchange inversion", is believed to occur as a result of changes in alignment. Below this temperature, the exchange interactions between electrons are thought to align the magnetic moments of the manganese atoms to give cancellation and no net magnetic force. Above the transition temperature, the electronic interactions change to give a new alignment of magnetic moments yielding a net magnetic force.

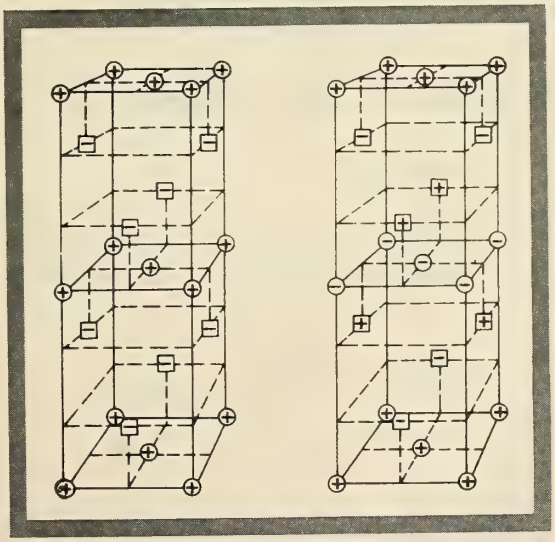
The change is simultaneously accompanied by a decrease in physical size of about 0.25%, with a composition whose transition occurs in the room temperature range. The company pointed out that there is apparently a critical interatomic dimension at which the transition occurs, and that this dimension falls within the normal thermal contraction range of the material.

The key adjustment made during fabrication, in order to produce the desired profile of transition, is in the proportion of chromium. DuPont experiments show that the transition temperature can presently be varied from near absolute zero to over 100°C. Transition occurs without hysteresis.

Maximum magnetization in the antimonide occurs just above the transition temperature, whereas it is near absolute zero with most materials. The company says a maximum magnetization of about 2000 gauss is typical of samples with transitions that occur in the room temperature range.

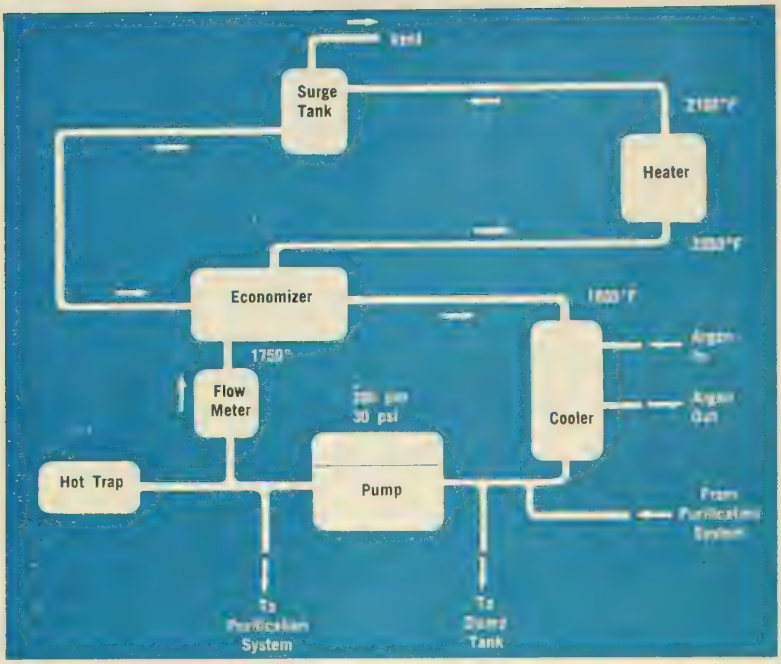
As temperatures increase above the transition point, the material exhibits normal ferromagnetic behavior, with magnetization decreasing until it disappears at the Curie temperature of 250°C for compounds with room-temperature transitions.

Other compounds exhibiting the characteristics include those using Mn and Sb with V. Co. Cu. Zn. As and Ge. ⁂



LEFT: *The magnetic structure of Mn_2SB. Layers of Mn_I atoms (circles) are aligned antiparallel to layers of Mn_{II} atoms (squares). Above —20°C, the atomic moments of Mn_2Sb are parallel to the* c *axis. Between —20°C and —40°C the moments becomes perpendicular to the* c *axis.*

RIGHT: *The proposed antiferromagnetic structure below the exchange inversion temperature for chromium-modified Mn_2Sb The moments are perpendicular to the* c *axis.*



LEFT: *The lithium loop is in the form figure-8 with the economizer located a overlap. An annular-type heat exch shoves the temperature up from ar 1800°F to 2050°F. A tantalum ra heater adds about 50°F to the hot si the loop. On the return path through exchanger, the lithium is cooled to 1800° again.*

The entire loop is "live"—the syste spring-mounted to allow for the inevi movement caused during operation. W metal bellows valves are used and dissi metal junctions are either welded using tallic intermediates or modified Mar Conoseal units.

Martin purifies both the liquid meta the argon inert gas. A cold trap (40 culls out residual lithium oxide after through titanium sponge. A molecular takes out moisture from the argon a hot trap further removes oxygen and gen.

Every component has been bench-t with the operational fluid at the req temperature. Martin has run countless periments in smaller loops to check materials compatibility and welds.

RIGHT: *Fully insulated loop is on t for easy movement into vacuum cha*

advanced materials

Liquid Metal Loop To Be Used by Martin

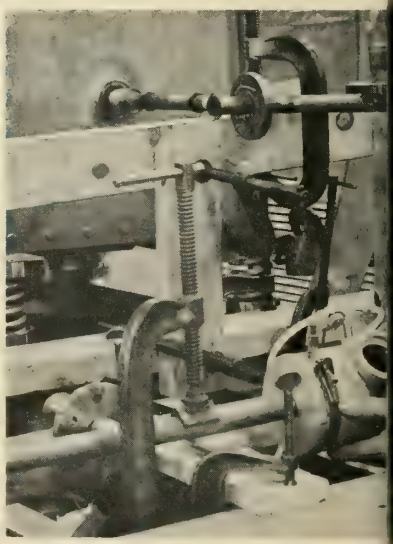
Massive columbium-alloy system will aid study of heat transfer for thermionic nuclear space reactors

by John F. Judge

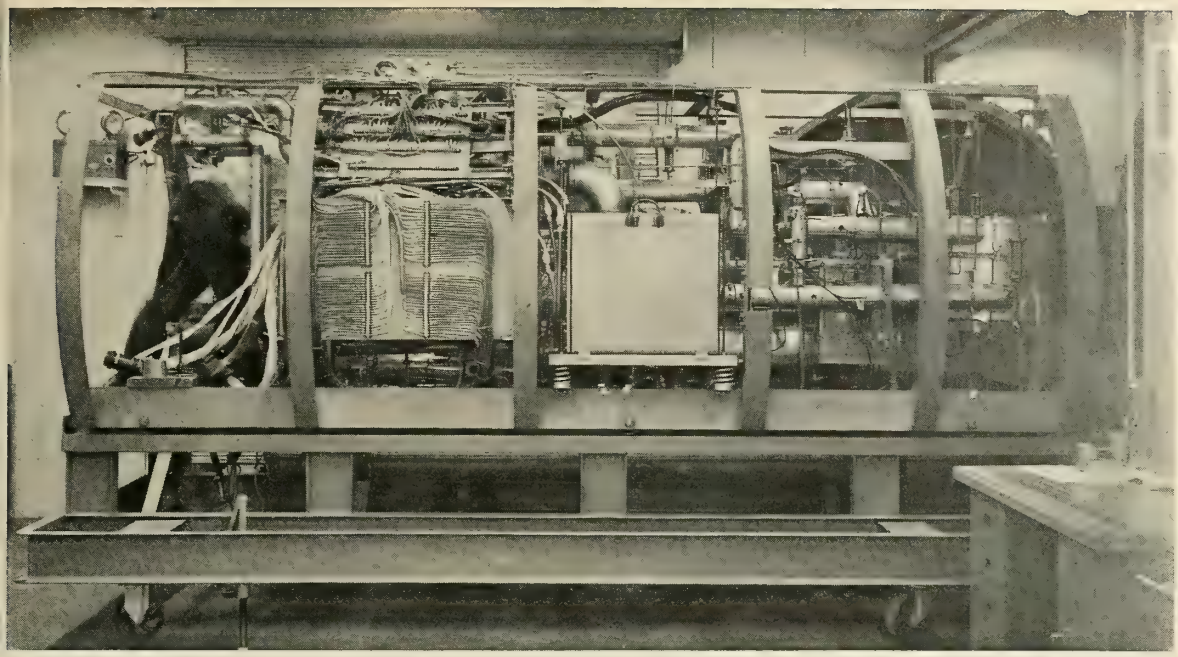
LIQUID METAL COOLANTS for compact space reactors involving thermionic power conversion will be studied in a huge new refractory loop at the Martin Co.'s Nuclear Division.

The figure-8 loop will operate at temperatures of 1850°F in the "cold" zone and 2100°F in the "hot" zone to provide basic heat transfer and fluid flow data.

The thermal convection loop consists of 1-in.-O.D. columbium alloy tubing capable of handling liquid metals such as lithium, sodium, potassium, cesium, rubidium and NaK systems. Costing in the neighborhood of $380,000, the entire unit and its associated



HIGHLY CRITICAL WELDS in columbium-alloy tubing which had to be done on the loop itself at the assembly area were handled with this sealed welding box.

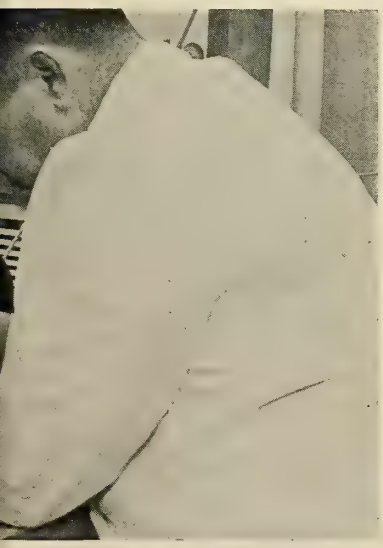


controls will fit into a large vacuum chamber capable of pressures down to around 10^{-3} mm. Hg.—or of being filled with inert gas.

Factors to be studied include corrosion, purification and handling techniques, environmental suitability of refractory materials and various components. Lithium metal will be the primary fluid.

Martin researchers feel that it's necessary to employ inert cover gases, rather than running the loop in a vacuum. The dry runs being carried out now will be followed by 3 months of "careful walking" at 1000°F.

The unit will be charged with about 75 lbs. of lithium, but the actual operational capacity of the loop is 25 lbs. It is completely instrumented, and automatic shutdown occurs whenever planned upper and lower limits are exceeded in flow, pressure and temperature.



• **Data collection**—The loop will be a working tool, designed to gather information in temperature regimes much higher than currently published data. The set-up has ample room for additional inputs.

The system itself is actually one massive exercise in design, fabrication and handling of refractory metals. Welding and mechanical joints are particularly crucial.

The liquid metals under study, especially lithium, are extremely active oxygen hunters at the temperatures involved. The two main effects of oxygen in the system are a loss of meaningful data from the particular run and a weakening of the loop itself.

The huge loop has thousands of surface square feet, presenting an outgassing problem in the vacuum chamber. Repetitive evacuations and filling with inert gases such as argon should bring the oxygen and nitrogen concentrations within the chamber to an extremely low number.

Martin engineers developed their own insulation systems and devised several methods of joining dissimilar metals. In the insulation area alone, the techniques involved saved the firm about $30,000.

Welding is a definite factor in the success of the loop. The columbium alloy is a difficult material to work and even more difficult to weld—in the sense of maintaining the desired metallurgical properties.

Most of the welding took place in the Martin shops under controlled atmospheres, but several joints had to be handled on the loop itself at the liquid metal facility.

For this operation, Martin engineers developed an air-tight envelope complete with welding heads which fits snugly around the tube joint. The welder filled the box with inert gas, started the welding operation and revolved the entire assembly around the tube, completing the juncture.

The biggest problem is one of environment. Besides working with liquid metals at high temperatures, the columbium alloy used to contain the metals has an affinity for oxygen and nitrogen at these temperatures. This compounded the insulation task, since both thermal and physical protection had to be provided.

The tubes are wrapped in tantalum foil and surrounded by a nickel foil and mesh thermal insulation system. This insulation has been evaluated at around 0.1 Btu ft.^{2}/hr.-deg. F in vacuum.

The liquid metal work is part of a long-range research program aimed at developing a family of compact reactors using lithium coolant and employing thermionic converters in each nuclear fuel element. The firm has developed designs in various power ranges, with most of the effort going towards a 300 KW system—the power level in demand for the 1965-70 period. ❖

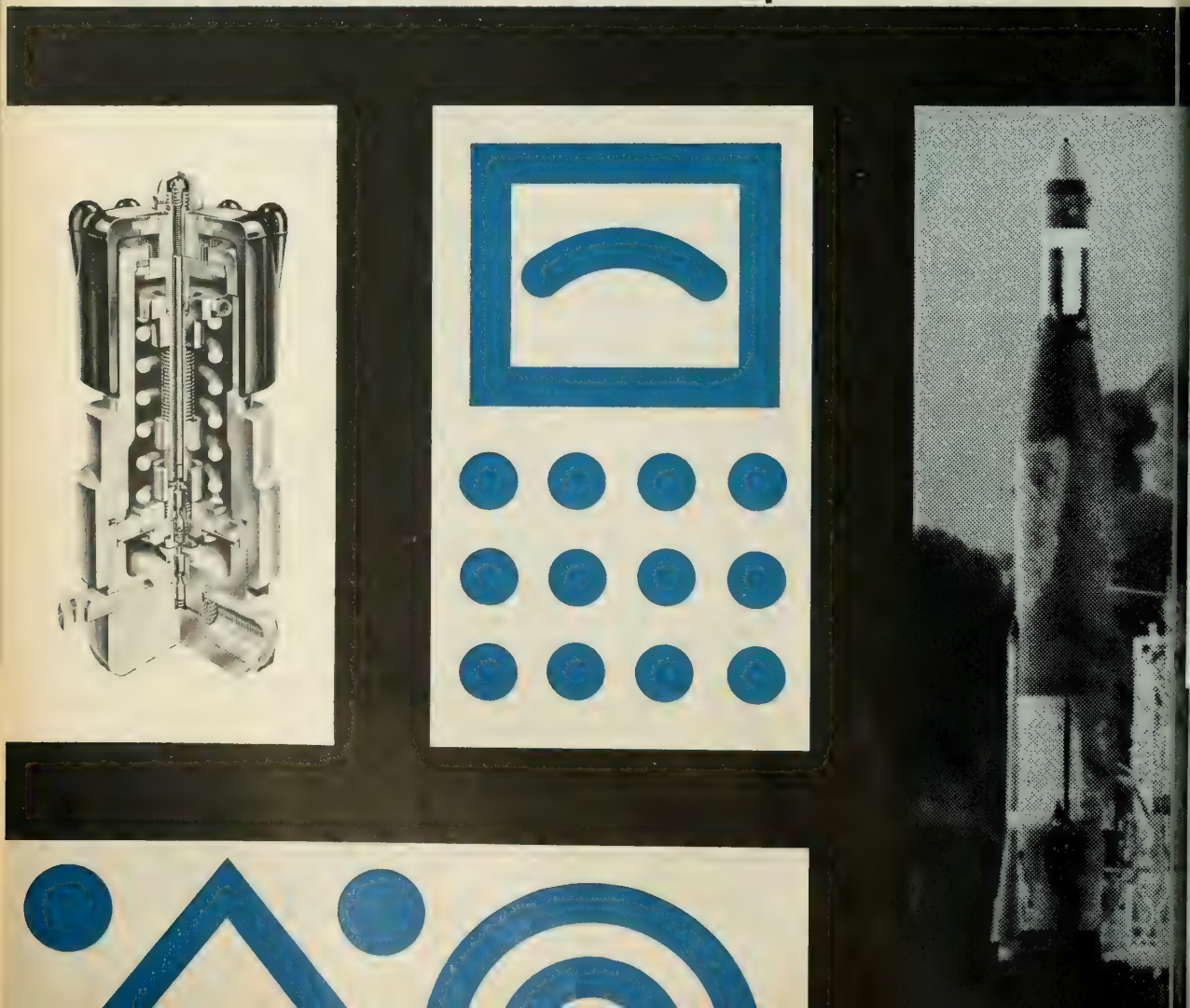
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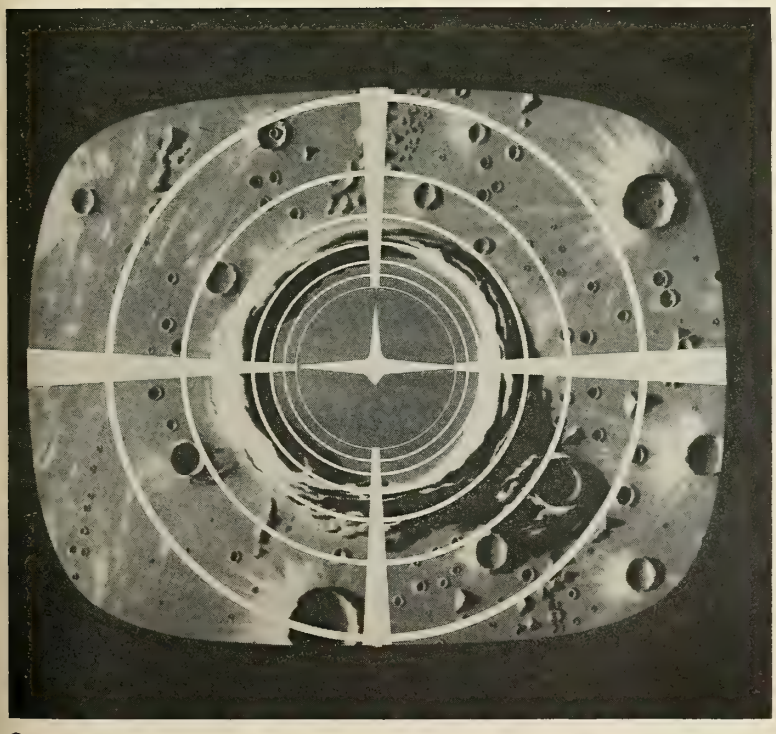
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'Conalog' Proposed As Moon Landing Guide

System long under development by Norden and GE for subs and aircraft is now viewed by many as useful for space

by Charles D. LaFond



CONTACT ANALOG displays such as this may someday guide an astronaut down to a safe landing on the moon. In this landing mode, the pilot simply keeps his simulated vehicle within the concentric cones representing his corridor.

U.S. SPACE VOYAGERS may be provided with a simulated roadway or corridor to follow—instead of facing endless hours of visual monotony during extended space missions.

Two companies, United Aircraft Corporation and the General Electric Company, have developed prototype hardware for such a system.

Called Contact Analog, or Conalog, the systems of the two developers are in essence the same, consisting of a TV display and a computer for storage and generation of navigation information and control parameters and for processing in-flight sensory imputs or course changes.

The continuous display presented to a pilot is a view of the situation model as seen from his control station. It is a real-time display which becomes visually analogous to contact control—and thus is called a contact-analog display.

The concept is not new, nor is its application for space use especially revolutionary. Nevertheless, it has found many opponents during the last five years of its development.

• **Beginnings**—It was conceived in the early years of the Army-Navy Instrumentation Program (ANIP), sponsored jointly by the Army Signal Corps, the Office of Naval Research, and the Bureau of Weapons.

As a result of work accomplished in experimentation with various contact analogs under ANIP, the Bureau of Ships awarded the Norden Division of UAC a contract in April, 1958, to develop a system for submarines.

Later, Norden received another contract for the design of a helicopter Contact Analog from Bell Helicopter Company, the coordinator of the Helicopter /VTOL-STOL portion of ANIP.

The first prototype system was delivered for Navy evaluation early in 1960, and was installed and operated in the submarine *Shark* throughout most of 1961. At a press conference in mid-1961, everyone associated with the nuclear sub's new Conalog rated it an unqualified success.

The Light Military Electronics Department of GE began its Contact Analog R&D under ANIP nearly seven years ago.

Its present contract is with Douglas Aircraft Co., to supply a Contact An-

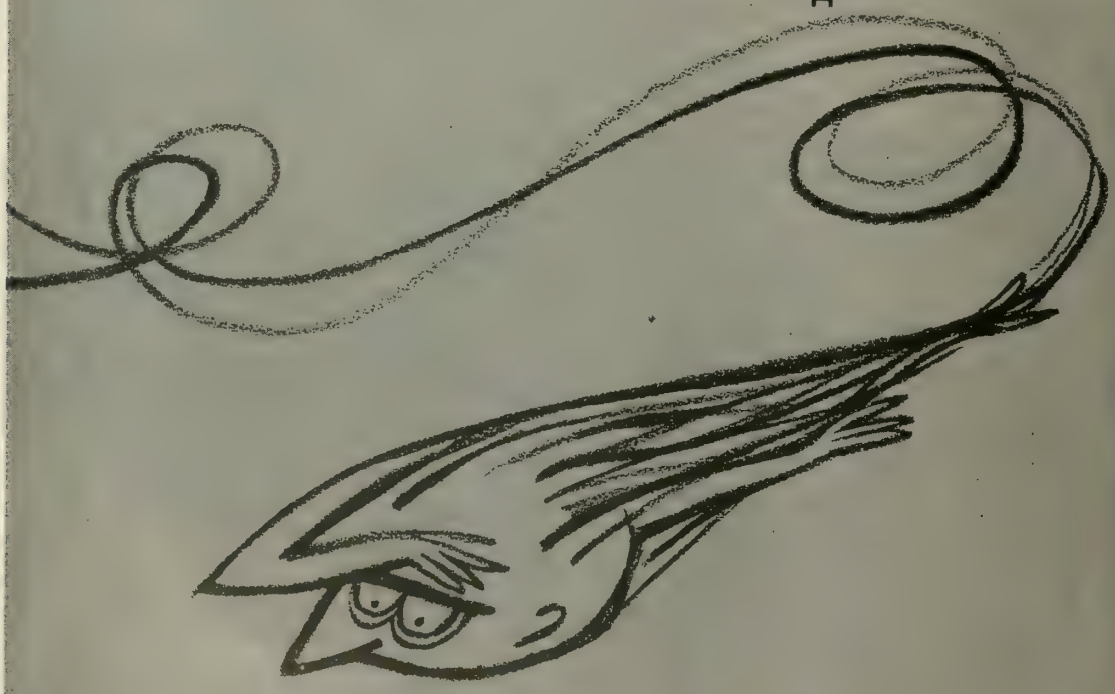
This is a satellite seeking re-entry . . .

Some men are satellites. There is a predictable period to their travels through the rocket motor industry. Sometimes sunseeking, occasionally mildly eccentric, always dependent, they find security in returning to the same old paths. ■ They will not find entry at UTC. ■ United Technology Corporation has an increasing number of positions open for scientists consciously seeking new paths. Important and challenging studies underway include multimegapound, segmented, solid propellant boosters; hybrid engines; ablation-cooled thrust chambers; filament-wound fiberglass rocket motors. Scientific staff members are preeminent in American rocketry. UTC is solidly backed by the tremendous resources of its parent organization, United Aircraft Corporation. The company's assets include a 30-acre Research and Engineering Center, and a 5,000-acre Development Center. ■ Satellite types won't rise to UTC's invitation. Those scientists who do will create America's rocket motors. ■ An Equal Opportunity Employer.

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Propulsion Engineer — For analytical studies of solid and liquid propulsion systems. Requires degree with extensive mathematics, thermodynamics and fluid mechanics background.

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United Technology Corporation

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alog display for a Douglas flight simulator. Douglas is prime on this ANIP system for both the Signal Corps and the Navy.

• **Underwater analog**—For its submarine system, Norden engineers assumed three parallel planes: the water surface above, the ocean floor beneath, and a "roadway" located between the other two at ordered depth.

The extreme planes are considered to be made up of 300-ft.-square uniform grids. The roadway is about 29 ft. wide. When at ordered depth it is situated 11 ft. below the pilot. Strips at 300-ft. intervals mark the roadway.

A bright speed-marker spot is superimposed ahead on the roadway. This represents another ship traveling at command speed. Thus, if the ghost ship approaches or recedes, the pilot adjusts ship's speed accordingly.

Upon an order for course or depth change, data are fed into the computer and the response is immediately shown on the display. That is, for depth change, the roadway moves up or down; for course change the roadway bends. The operator simply adjusts to follow the road.

For shallow-depth or near-surface operation, a grid size change can be employed. In the fine mode, grids are 20-ft.-square. A change in grid pattern is used to prevent confusion between grid scales.

Basic system inputs include trim angle, depth, ordered depth, speed, heading, ordered course, and roll. However, other inputs may be employed to superimpose, or alternatively to select, one of a number of displays on a single display tube. These could include sonar, radar, closed-circuit TV, and the contact analog.

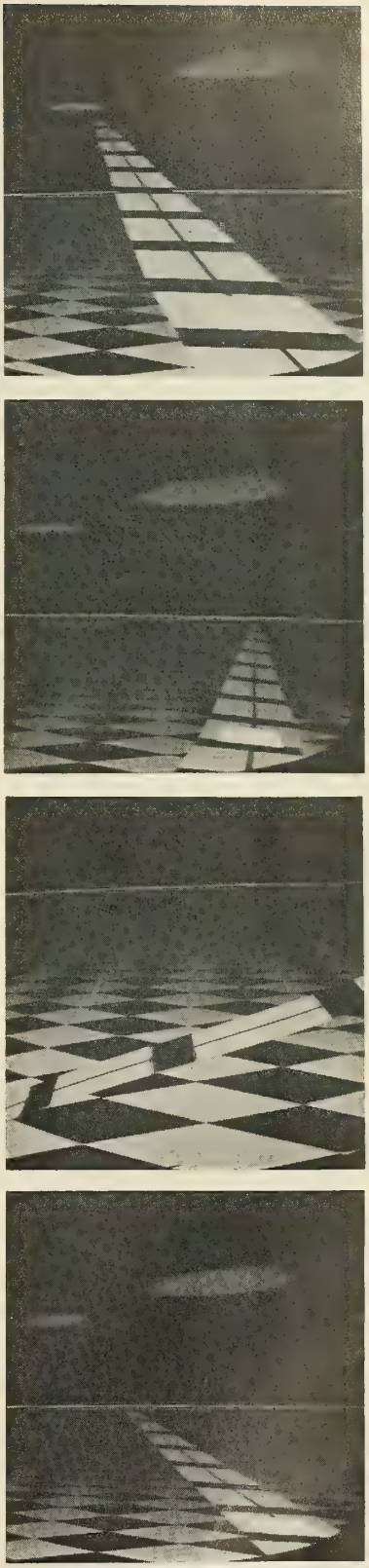
By employing a "quickening" computer process, the helmsman no longer has to anticipate and compensate for the sub's dive and turn characteristics to avoid overshoot.

Tests so far have shown that by using the quickening process with the Conalog, an inexperienced pilot can handle a 10-ft. dive order combined with a turn. Without this system, the operation would offer little chance of success, officials say.

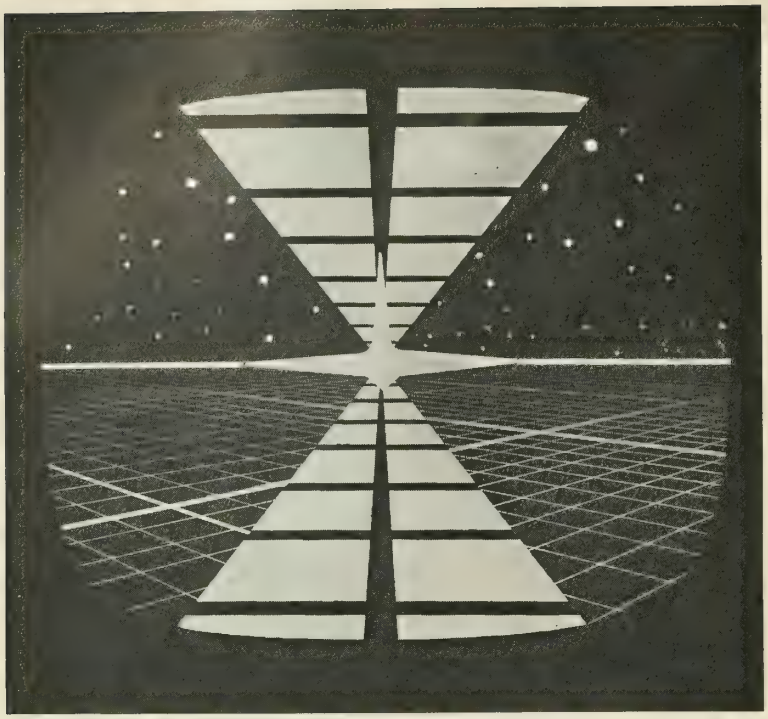
• **High-speed system**—The GE system, developers say, is designed for use in a flight simulator or in high-performance aircraft to generate an artificial visual reference.

This simulated world would show, in true perspective, a ground plane with all the information relative to the six degrees of freedom. It also would include a flight path (or roadway).

The system was demonstrated for the first time by the Navy in Washington last week, although it did not in-



DISPLAY variations for aircraft.



RE-ENTRY CORRIDOR of a spacecraft might appear like this on Norden's Contact Analog. The lower grids represent the Earth, the two roadways the pilot's upper, lower, and lateral limits. At the proper times in flight, the roadways will bend to bring the craft into the target area.

clude the flight path generator which will be a part of the final system.

When it is eventually married to the Douglas flight simulator, two goals may be reached: 1) the evaluation of pilot performance when using both ANIP or standard control panels, 2) the determination of the best contact-analog configuration within the state of the art for high-performance aircraft.

In general, the Norden and GE systems are similar. The present Nordem system has a power requirement of 150 watts. The improved-design Conalog system may have power needs as low as 30 watts, the company says.

The GE system now requires about 250 watts.

Both systems have been transistorized and each uses digital circuitry.

• **The cons**—Each also employs a cathode ray tube. This is the basis of reported Air Force reluctance to support Contact Analog development. Opponents feel CRT's are too big, require too much additional power, and would have doubtful reliability. New advances in this field may allay the opposition.

Pilots apparently have shown a wariness toward the system, but this is not a new problem—they also resisted such improvements as Ground Control Approach, autonavigators, and radar.

Others feel this might be too much of a system for ordinary aircraft use—an unnecessary luxury. At the same time, they feel that the real future for such systems could be in space.

The whole display problem is somewhat up in the air now. Under an Air Force program, Lear has been studying cockpit design, instruments, and pilot controls for years. MIT is now making a display/power/size study of conventional versus Conalog systems. Minneapolis-Honeywell is also studying the whole problem for *Apollo*.

• **Space applications**—Three years ago attempts were made to sell the Air Force on the use of Contact Analog in *Dyna-Soar*. Today, developers appear to be aiming chiefly at NASA's *Apollo* and follow-on vehicles.

The high-G environment in space can affect pilot vision and restrict his normal field of motion and view. The Contact Analog offers an opportunity to reduce the usual maze of instruments to a single screen during normal flight control or monitoring, proponents say.

They assert that the system provides an ideal multiple-purpose primary display for space vehicles, where cockpit space is at a premium and direct view of the outside world is extremely limited. The same equipment can also present television or infrared pictures of the outside environment. These pictures may be superimposed on the contact analog patterns or presented separately.

The ability to combine real and artificial views on a single display is, they argue, of extreme value in space, where the real view of the outside has relatively little value when the space ship is at a great distance from a planet or other body of interest. The real view which could be provided from television becomes of interest as the planet or moon is approached, and can be smoothly blended into one display.

This technique of combining synthetic and direct display data is particularly valued in lunar landings and reentry situations, its backers say. The pilot has the confidence of knowing the actual situation by seeing what he is approaching. At the same time, he has command signals and reference orientation information directly in his field of view.

In addition to the landing mode, the same basic display continuously represents the conditions of flight during mid-course navigation, and can present emergency command signals and other instructions.

Since the contact analog picture is generated in a standard TV raster, the display unit also can present any other information which can be made available in standard television format. This permits its use as a general-purpose view screen capable of other modes—such as monitoring television views of inaccessible portions of the vehicle and displaying information transmitted from earth in TV format.

If a periscope providing direct outside view is also available, the effect of contact analog display on pilot's light adaptation becomes important. (This problem was solved by Norden in both aircraft and submarine applications by providing a wide range of light intensity control.)

The display is not dependent on external computers or other equipment for generating any of its patterns of symbols. However, it does require scaled voltage inputs which represent the background data and command orders that are to be displayed to the pilot. The circuits and techniques used by Norden and GE are capable of generating a wide variety of synthetic patterns and symbols. The present equipment provides surface grid patterns, roadways, aircraft markers, speed markers, and command symbols.

Neither developer believes it has all the answers to all the problems for space flight control display. Those close to Contact Analog feel, however, that it offers enough clearcut advantages to assure a useful role in space.

All they need is a program assignment in which to prove it. ⌘

$1-billion development . . .

Titan III Plan Awaits DOD Approval

System package plan calls for 17 development launchings; big advantage of booster is flexibility

by James Trainor

DEVELOPMENT COSTS of the *Titan III* Standardized Space Launch System are expected to be "in the $1-billion range," says Col. Joseph S. Bleymeier, Air Force program manager for the booster.

UTC has been chosen to build the 120-in. solid booster (see p. 12).

Titan III—or, as the Air Force prefers to call it, Program 624A—will provide a reliable and short-reaction-time vehicle for military space missions over "the next decade," Bleymeier told a press gathering at the AF System Command management conference in Monterey, Calif.

Having completed the Phase I Preliminary Design effort on the *Titan III* concept, the AF has submitted the system package plan to the Department of Defense and is now awaiting final review and approval of the program by Secretary of Defense McNamara.

In Phase I, Bleymeier said, the Air Force verified the feasibility of the concept and determined the technical characteristics of the vehicle and its support facilities. It then evaluted the systems approach, according to the guidelines laid down by both DOD and top AF officials, and determined the technical risks involved in achieving them.

Once this was achieved, AFSC's Space Systems Division established a firm development plan involving the launch of 17 development vehicles including 12 core *(Titan II)* vehicles and five full *Titan III* vehicles, and a recommended AF management structure and contractor plan.

The guidelines for the program, he said, were to develop a system:

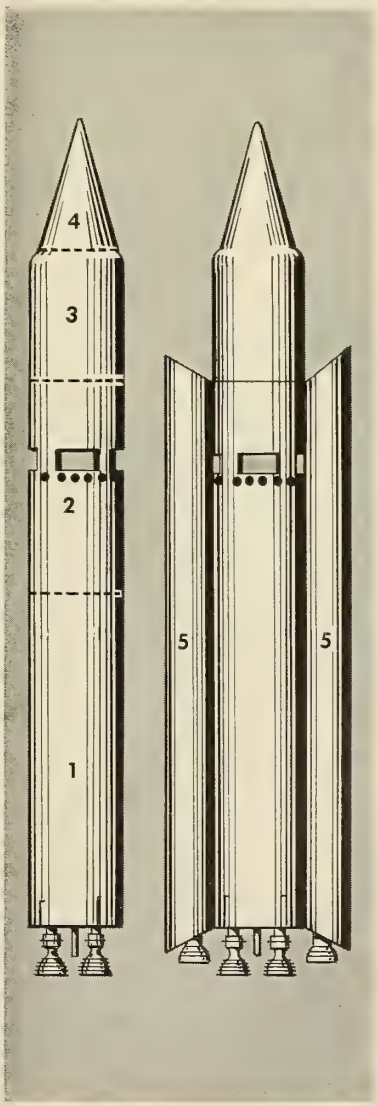
—Based on presently available technology (1960-62).

—Possessing a wide mission capability over the next 10 years.

—Having high reliability.

—Offering maximum cost effectiveness.

—Consistent with both costs and schedules.



'CORE' Titan III is modified Titan II vehicle (left) with four stages (see text). Full Titan III would have two 120-in. solid boosters (5) attached.

• **Lessons from past**—In developing the *Titan III*, the Air Force examined all its ballistic missile systems as well as *Polaris* and *Saturn* before drawing up its system package plan.

One of the principal concerns was to reduce the pad time of the space booster from months to days. This led to the development, in the AF's Phoenix studies conducted over the past year or more, of the integrated transfer and launch concept. This is expected to reduce the time the vehicle is on the pad to a maximum of 15 days.

In this concept, the vehicle core would be assembled and checked out in a vertical integration building and then moved by rails to a second building where, if required, the two large solid boosters would be attached. From here, the *Titan III* booster would move along rails to one of three launch pads for final preparations and firing.

The siting of these pads at Cape Canaveral, however, has been a matter of controversy between the Air Force and NASA (M/R, April 30). Work is progressing on modification of pad 20, formerly used for *Thor*, to accommodate the *Titan III* core vehicle.

Although the Air Force had been studying the large booster for military missions for some time, it was not until Sept. 15 of last year that the Director of Defense Research & Engineering formally requested the preliminary study of the standardized space booster.

NASA yielded to Pentagon's design wishes . . .

Because of its prior work in this area, the Air Force was able to submit a report to DDR&E 11 days later, and received approval for a Phase I study on Oct. 13.

• **Design snag**—A vehicle of the *Titan III* class had been recommended by the Golovin committee, consisting of experts from both NASA and the Defense Department, including the Air Force. However, as Secretary McNamara later told a Congressional committee, the final agreement—required between NASA and DOD before either can develop a launch vehicle—was delayed three to four months by a controversy over the vehicle design.

NASA reportedly felt that the launch vehicle should be just a beefed-up *Titan II;* DOD felt that this was insufficient. The civilian space agency wanted to make essentially the same changes it had made in its *Mercury-Redstone* booster—elongating the fuel tanks and strengthening the structural members to increase the *Titan II's* payload ability.

DOD opposed this make-shift arrangement which it felt would not be adequate for space missions over a period of 10 years or more. Eventually, NASA yielded to Pentagon desires.

Subsequently, the Air Force submitted its system package plan to DOD on April 30, 1962, and is now awaiting the development go-ahead.

• **Flexible**—One of the principal advantages of the standardized *Titan III* space booster will be its flexibility. Built around the modified *Titan II,* the booster will be able to boost payloads of 5-20,000 lbs. into low-earth or synchronous orbits or into escape trajectories. In addition, *Titan III* will be capable of a limited growth as payload sizes increase.

The core of the vehicle will be the *Titan II*—modified to provide additional structural strength and an air-start capability. It will develop 430,000 lbs. of thrust, using storable, hypergolic propellants and two pump-fed engines.

The second stage of the core uses the same fuels and will produce 100,000 lbs. of thrust. The third, or transition, stage will have two engines providing 8000 lbs. of thrust each. To this will be added what the Air Force calls a Subsystem Module, containing the guidance, auxiliary power and other booster systems.

For missions requiring a high payload capacity, two 120-in. solid boosters will be attached to the core. Each of these large solids will produce 1 million pounds of thrust and weigh 500,000 lbs. Although the basic solid booster will have four segments in addition to a fore and aft closure, a fifth segment can be added.

Additional payload capability can be obtained, the Air Force feels, by uprating the *Titan II* first stage to 500,000 lbs. of thrust and increasing the thrust of the upper stages.

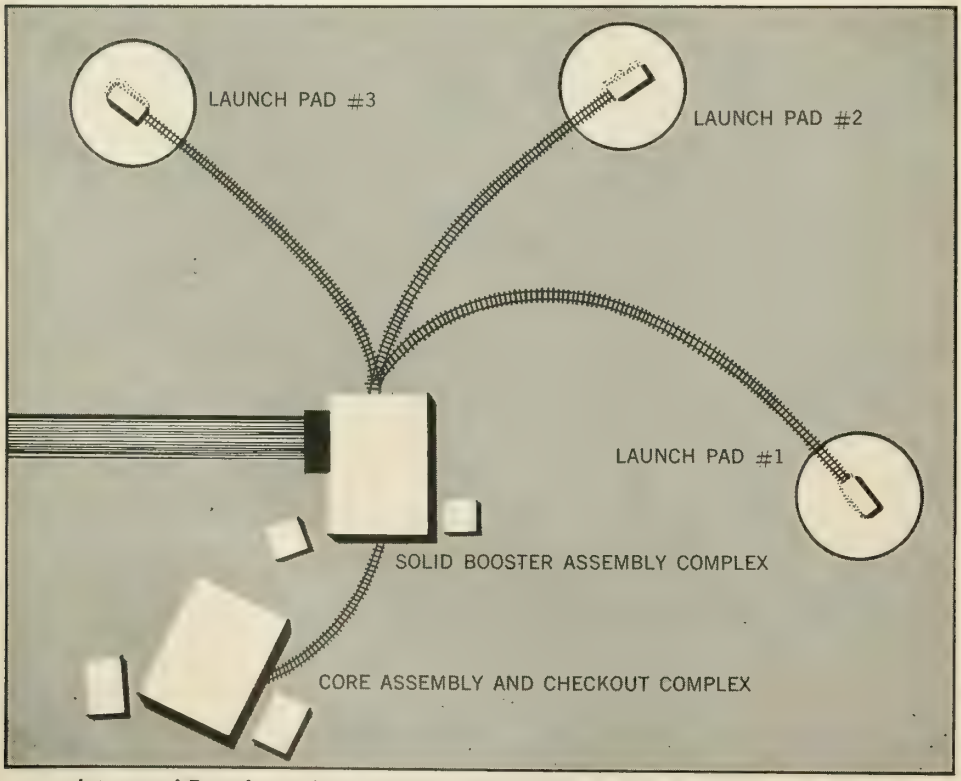
Titan III, since it will be used for the manned *Dyna-Soar* flight program, will also have a malfunction detection system for pilot safety. For unmanned missions the AF will provide a standard payload shroud for the booster.

• **Management**—In setting up the management structure for the program, several unique management techniques were included. System costs were established at the outset of the program and the program planning and work statements have also been developed.

Titan III also will be the first program to use PERT/Cost from its inception, as well as the first to use the cost-plus-incentive-fee contracting procedures on a large scale.

Although source selection has been completed, announcement of the complete contractor structure is being delayed until the program is approved for development. Some of the contractors already identified for the preliminary phases of the program are: The Martin Co., the basic core vehicle (modified *Titan II);* Aerojet-General Corp., liquid propulsion; Space Technology Labs and American Bosch Arma Corp., guidance system; Operations Research, Inc., PERT/Cost techniques; Ralph E. Parsons, Inc., A&E work at Atlantic Missile Range; Aetron, Inc., A&E for test facilities at Edwards AFB.

Announcement is expected soon of the contractors for the trans-stage engine, the large solid boosters and the A&E work at the Pacific Missile Range. ⌗



Integrated Transfer and Launch Plan Cuts On-Pad Time to 15 Days Maximum

COSPAR Medicine

(Continued from page 17)

ber of heavy primary hits by a factor 15 or 4 during solar minimum or solar activity years, respectively. In long-term excursions, with quantities of propellant and supplies also available for shielding, the number of hits would decrease to zero.

He said that the radiation of the Earth radiation belts is no major hazard if the vehicle crosses the inner belt in 10 minutes. Although solar flares still present the major problem, this too can be overcome with proper shielding.

"If supplemental shielding is provided by appropriate positioning of equipment and supplies, the necessary additive weight for individual shielding should hardly surpass 25% of the space-vehicle weight as it is envisioned, even for smaller vehicles without regard to shielding."

The biological danger of the heavy cosmic-ray particle will probably not constitute a serious problem for space-flights of a few weeks duration, laboratory studies at Brookhaven National Laboratory show.

A narrow beam of 22 mev deuterons was developed which has the same biological effect as the track of a very heavily ionizing particle. According to H. J. Curtis, astronauts will very likely come back with gray hair, but will not suffer any significant brain or eye damage, as many had feared.

• **Exobiology** — The Soviets gave emphatic assurances that they were very concerned that any spacecraft impacted on any other heavenly body should be sterilized to prevent Earth microbes from contaminating it.

They revealed that they will be looking in their interplanetary probes for simpler substances than actual living creatures, from which life may or may not have evolved. They said they would try to detect organic phosphorus compounds, porphyrins and amino-nitrogen.

They also said that they were not convinced that anyone had proven that any meteorites found on Earth contained any form of life. "It should not be overlooked that with few exceptions meteorites remain lying in the ground for more or less long periods before they are taken for examination." During that time, they said, the meteorites probably absorbed the organisms which some scientists identified as life from other planets or stars.

The Soviets said they will look for photosynthetic bacteria which evolve no oxygen, bacteria with high resistance to radiation and extreme temperatures and no need for water.



Air Force 85-Foot Reflector

FIRST DETAILS of new high-gain telemetry antenna system, being developed by Radiation, Inc., Melbourne, Fla., are shown in this artist's conception. Two of the systems, which will be used on AMR and PMR, are included in a $1.5-million contract with AFMTC, AFSC, Patrick AFB.

They emphasized that radiation, vacuum and low temperature will not kill microorganisms on the surface of cosmic rockets and space ships. And that ultraviolet radiation cannot be relied upon to sterilize the outside of a spaceship, since a particle of cosmic dust containing a microrganism cell may afford it adequate protection against ultraviolet radiation. ⁂

COSPAR Wind-up

(Continued from page 16)

sun-facing side of the moon "plastered" with a thin skin of a magnetic field having a strength of the order of 10^{-3} gauss; and the back side of the moon looking at magnetic lines of force circling around at great distances away. Clearly, the magnetic field would show strong diurnal variations.

The hydrogen around the moon could be detected at the Lyman-alpha wave lengths and would manifest itself as a halation of scattered light, according to Gold.

Two important consequences of Gold's work are foreseen if his hypotheses are borne out: the character of the atmosphere around the moon would give an insight into the strength and character of the stream of solar gas; and the magnetic field would give information about the moon's interior.

• **Too hot for life** — Venus was again sized up as too hot for earthlings, even though the planet's surface temperature was possibly altered downward by a hundred or so degrees during the COSPAR conferences.

Goddard's Dr. Robert Jastrow told of calculating just how opaque Venus' atmosphere had to be to get a greenhouse effect able to keep the planet's surface temperature at the 600° K figure usually accepted. He concluded that the atmosphere could permit no more than one part out of 10^{26} parts of infrared radiation to escape to outer space.

To get this degree of opaqueness Jastrow hypothesized a water vapor-carbon dioxide atmosphere; but this brought the planet's surface temperature up to only 320°K—about the temperature of the Sahara desert on a clear day—indicating that the trial atmosphere was not opaque enough.

Jastrow recommended the conclusions of Hyron Spinrad, Jet Propulsion Laboratory, as possibly coming closer to the truth.

Spinrad sees the Venusian atmosphere being made up principally of nitrogen and only a relatively small amount of carbon dioxide. The nitrogen is under an equivalent pressure of seven to 10 Earth atmospheres, and the carbon dioxide under only about one-half atmosphere. Under these conditions, the Venusian atmosphere is seen being quite opaque to the infrared.

Jastrow observed that a spurious layer embedded in the Venusian atmosphere might be throwing radio astronomers off by 100°K in their estimate of the planet's surface temperature. However, it will still be difficult for life to survive under a temperature of 500°K, the scientist observed. ⁂

AF Urges Better Subcontract Handling

At Monterey management conference, industry reacts with skepticism to service's charge that it must intervene

by Willard E. Wilks

MONTEREY, CALIF. — Tight Air Force controls over subcontracting by its prime contractors can be relaxed when industry is willing to assume appropriate responsibility in this field.

That was the word passed to top-ranking industry executives at the Air Force Systems Command management conference here. In the light of current trends, the announcement, predictably, met some skepticism.

But AF spokesmen insisted that failure of prime contractors to recognize and live up to their full responsibilities in administering subcontracts was the cause of AF intervention.

AFSC indicated willingness to decrease these controls when primes assume more responsibility for subcontract management. Seminar studies of the problem at the Monterey conference recommended:

- Elevation of material and procurement management by primes to a high organization level—preferably under a firm's chief executive officer.
- Maintenance by primes of a staff adequate for proper subcontract management.
- Clarification by the Air Force of the responsibilities of primes in this area.
- Acceptance by the Air Force to a greater degree of primes as subcontract administrators.

Considerable attention was devoted at the conference to the new Department of Defense approach on incentive contracting. Industry leaders favored the increased emphasis on incentive buying. But they want better guidelines on Air Force and DOD sincerity—and on just how the two organizations intend to apply incentive principles.

Industry made it clear it would be slow to accept incentive theories in actual contract negotiation without assurance of detailed, well-established ground rules which would be strictly observed by the Air Force.

AFSC representatives admitted that the main hindrances in putting more incentive-type contracts into effect have been the instability of the contract base, inadequate specifications and statements of work, numerous contract changes, and the extreme difficulty of measuring performance against contract requirements.

Industry leaders at the conference also expressed doubt they will be allowed to retain increased profits earned under incentive contracts—despite public assurances from the Renegotiation Board and from DOD Deputy Secretary Roswell Gilpatric at the conference.

Addressing an audience of 300 top military and civilian managers, Gilpatric released no advance text of his speech, nebulously titled "New Dimensions in Defense Management." With only personal notes in front of him, the Deputy Defense Secretary gave one of the clearest and most important expositions of the trends within DOD over the past years as well as an insight into probable changes to be effected during the coming year.

- **Hitch Program set**—For the first time it was revealed that the Hitch Program packages have been completed for the 1963-67 time period and that the services "can't change a line in it" without the approval of Secretary McNamara or Gilpatric.

Admitting that this "may be too rigid a control" and that his audience had a right to be skeptical about its effectiveness, Gilpatric defended the action on the grounds that, at the high level of defense expenditures over the next five years, DOD has to maintain increased cost controls.

Through 1965-67, Gilpatric revealed, the Defense Department plans to spend $50-55 billion—"not taking into account new weapons" introduced into the force structure.

Listing the areas of military development of space—in addition to "major NASA support"—as including reconnaissance and surveillance, defense systems and support systems, Gilpatric admitted that "as yet we have no established program" in the areas of the offensive and command and control.

"Within the next six months," he promised, "we will get about our business in this area." ⌘

Centaur Probe

(Continued from page 13)

laying the satellite and spacecraft programs, the unsuccessful first launch means that the feasibility of liquid hydrogen upper stages remains unproven.

On such proof rests the future of NASA's *Saturn, Advanced Saturn* and *Nova* boosters. Each utilizes upper stages powered by the same liquid hydrogen-liquid oxygen propellant combination used in *Centaur*.

During the flight, it was planned to rocket the *Centaur* about 300 miles into space and then attempt to ignite its two engines as the first flight test of the propellant and its propulsion unit.

- **Centaur's power**—*Centaur's* propulsive unit consists of two Pratt & Whitney RL-10 hydrogen-oxygen engines. Each engine generates 15,000-lbs. thrust with a specific impulse well over 400 sec. Its nozzle expansion ratio is 40 to 1 and the chamber pressure (nominal) is 300 psi.

The units employ the so-called "boot strap" system, using the liquid hydrogen first as an engine coolant, and then as the turbo-pump driving fluid, before combustion.

Since the RL-10 is designed with re-start capabilities in mind, conventional lubricants could not be used in the gear box. The gears and bearings in the RL-10 turbopumps operate dry with hydrogen cooling.

The RL-10 engine has undergone more than 700 separate tests, for an accumulated firing time in excess of 60,000 seconds. ⌘

Aerospace Unions

(Continued from page 15)

most total involvement of the government and of the Federal subsidies made to these firms.

The UAW negotiations that began last month at North American (about 45,000 UAW workers) and Douglas (20,000) should give a pretty good indication of how the rest of the talks with industry will go. The current NAA contracts expire June 3. Douglas contracts expire June 15. The termination dates of the contracts with various firms are staggered, and bargaining is likely to go on all summer.

Other key UAW contract expiration dates are: July 4 at Chance Vought (Dallas), July 8 at Ryan (San Diego), July 15 at Martin (Baltimore), for wages only, Aug. 24 at Ryan (Torrance), Sept. 30 at Curtiss-Wright (New Jersey), Oct. 8 at Boeing-Vertol (Morton, Pa.) and all Temco plants, and Oct. 15 for Martin (Orlando) for wages only. ⌘

Contracts and Geography

California companies are getting an overly-large percentage of contracts from two AF procurement divisions, while New York is getting too little, Senator Kenneth Keating (R-N.Y.) told the Senate last week. Claiming that there should be greater diversification of contracts, Keating cited figures showing that: Space Systems Div. concentrated 73% of its awards in Calif., .2% in N.Y.; Ballistic Systems Div. spent 48% of its funds in Calif., amounting to $1,300,910,562 out of a total $2,429,964,718, while spending 4% in N.Y. He also cited the Army Engineers Construction Div., which he said spent 22% of its funds in Calif., none in N.Y. "These statistics are alarming," said Keating, "not only for New York, but for the nation." He did agree, though, that there was no evidence of fraud or collusion in the situation and that procurement policies provide for participation of all states. Meanwhile, Boeing president William M. Allen told a Seattle, Wash., audience that Congressmen who espoused pork-barrel philosophy in the award of military business did not really believe in the use of private industry to design and build weapon systems. He said "we are familiar with the pressures and public statements of certain of our legislators designed to influence the placing of business on need for employment or geographical distribution. The contractor who stimulates such activity is in a very real sense participating in the elimination of private industry in the defense effort."

News of Mergers and Acquisitions

Metcom, Inc. and Elcon Laboratory, Inc. have agreed to negotiate a merger. Metcom manufactures microwave tubes and devices in Salem, Mass. Elcon conducts basic research in the fields of optics and plasmas at its Cambridge, Mass., lab. . . . *Hooker Chemical Corp. became sole owner of HEF, Inc. by acquiring the 50% interest held by the Foote Mineral Co. HEF produces chemicals for solid fuel rocket propellants in Columbus, Miss.* . . . REDM Corp. acquired Micro Pen Corp. and its two wholly-owned subsidiaries.

New Industry Facilities

Aerospace Corp. bought an 80-acre site near Norton AFB, San Bernardino, Calif., for office and research facilities. The move will insure technical support of AFSC Ballistic Systems Div., which is moving to Norton from the Los Angeles Area. . . . *North American Aviation's Los Angeles Div. is modernizing facilities by relocation of many departments, removal of several buildings, and construction of one new building. First phase of the four-part program is an upgrading of present office, engineering and manufacturing area. Also planned is a new R&D and administration building.* . . . The McKay Machine Co., Youngstown, Ohio, broke ground for a new office and manufacturing facility as part of a $4.5-million corporation-wide modernization program. The new plant will centralize work being done in two plants and part of a third. . . . *Air Products and Chemicals, Inc., Allentown, Pa. announced a $16-million expansion of its industrial gas producing and distribution installations. Major plants are being built at Delaware City, Del., and Chicago. Plants will start operations in early 1963 and will be capable of producing up to 600 tons a day of liquid products.* . . . Aerojet-General Corp.'s AETRON Div. is building an addition to its Foothill Facility which will double space for fabrication of advanced electronics instrumentation systems used in a wide variety of space programs. The division provides architecture, engineering, and construction management services on major government space facilities and civilian scientific installations. . . . *Bissett-Berman Corp. is building an addition to its headquarters office and laboratory building in Santa Monica, Calif. The company is engaged in information electronics R&D for military applications.* . . . H. I. Thompson Fiber Glass Co. established a new plant in Atlanta, Georgia, to produce high-temperature and acoustical insulation for missile and jet aircraft use. . . . *Advanced Data Systems Corp. moved to a new location in West Los Angeles.* . . . Instrument Systems Corp. is building a new headquarters building in Hicksville, L.I. . . . *Rixon Electronics, Inc. plans to double existing development, manufacturing and administrative space by building an addition to its Silver Spring, Md., plant.* . . . AMETEK, Inc., will build a new $2-million plant in Lansdale, Pa. for its Hunter Spring Div. Completion is scheduled for next January. . . . *INVAC Corp. moved into a new plant in Waltham, Mass., along with its subsidiary, Reed Manufacturing Co.* . . . Weinschel Engineering Co. will build a new plant near Gaithersburg, Md. The company designs and manufactures instruments and components for use in the microwave field. . . . *Air Reduction Sales Co. is building an ultra-high purity gaseous hydrogen producing plant in Moraine City, Ohio, a suburb of Dayton.*

New Names in The Industry

Hanjohn Co., Inc., South El Monte, Calif., changed its name to Accurate Resistor Corp. The company manufactures resistors comprising standard size, subminiature, and microminiature precision wire wound units; both ceramic and encapsulated types. . . . *Holley Computer Products Co. has been formed as a joint venture of Control Data Corp. and Holley Carburetor Co., Warren, Mich.*

Corporate Division Changes

Rocketdyne Div. of North American Aviation established three Western and one Central regional office to "*. . . maintain contact with key government and industry personnel in order to expedite technical and contractual liaison.*" . . . Raytheon Co.'s Equipment Div. formed a technical staff to manage range and space ground support systems. Prime targets of the new group are instrumentation improvement programs scheduled for AMR, PMR and the global space ground support net.

MISSILES AND ROCKETS

INTER-OFFICE CORRESPONDENCE

From James W. Claar

To Craig L. Mason

Subject Industrial Marketing Ad

As you know, we are planning to run a MISSILES AND ROCKETS ad in the June Issue of Industrial Marketing.

There are several points I think we must get across.

First, let's emphasize our 6,000 circulation increase over the past twelve months, an average of 500 a month. At this point, I think we should mention that 55% (3,300) of the total circulation increase came from the circulation insert card. We used no circulation promotion gimmicks offering cut-rates, extra copies, etc.

Since MISSILES AND ROCKETS is the only weekly Space Systems-oriented publication serving the market, point out our complete coverage of propulsion, electronics, advanced materials, support equipment, industry, NASA, etc.

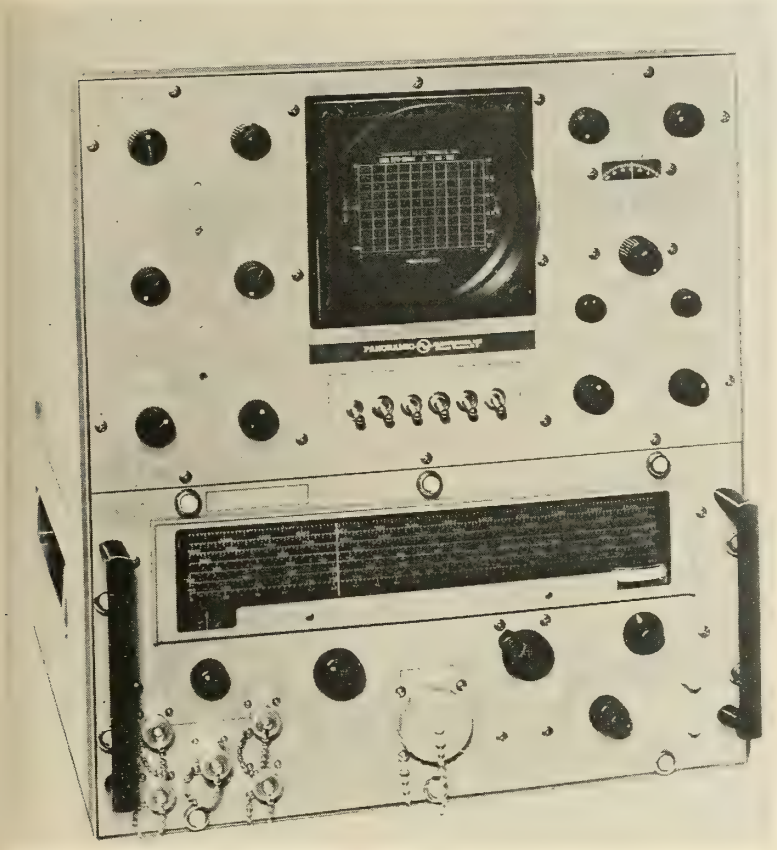
At the same time, I'd like you to give <u>top</u> billing to our 17-man editorial staff. You know some of the monthlies in the field are mostly contributed, and I want people to know that M/R is over 80% staff written.

Regards,

Jim

P.S. You might also mention that M/R was the only missile/space publication showing an advertising page increase in 1961.

kl



New Product of the Week: Panoramic Spectrum Analyser

A BROAD BAND analyzer for accurate and reliable measurement of pulsed or CW signals in the RF through Ka frequency range is available from Panoramic Electronics, Inc. The Model SPA-10 has 1% frequency accuracy, high sensitivity, single-knob frequency tuning, internal waveguide and coaxial mixers, and non-contracting, klystron cavity shorts. The analyzer also has extremely wide dispersion to 80 mc, adjustable 1-80 kc selectivity, and internal self-checking and calibration provisions.

The unit can be used by production-line personnel to measure pulsed signal spectra; for communications signal analysis; modulation studies in AM, FM or PM; malfunction and noise analysis; calibration and maintenance of signal generators; and analysis of low-level oscillators with BWO's and tunnel diodes. High usable sensitivity permits analysis of weak signals and narrow pulses.

Circle No. 225 on Subscriber Service Card

V-Scan Encoder

Guidance Controls Corp., subsidiary of Warner Electric Brake & Clutch Co., is marketing model ADC V-scan encoders for digital instrumentation and control systems which provide nonambiguous electrical representation of shaft position in straight binary code without external logic circuitry. Units come with capacities of 6, 11 or 16 bits in size 11 enclosures (1.062 in. dia.) with all logic circuitry and switching diodes self contained.

Circle No. 226 on Subscriber Service Card

Miniature Circulators

E & M Laboratories announces the availability of a new series of miniature 3-port circulators. These are the smallest know circulators—only one-fifth the volume of units having comparable electrical characteristics. Miniaturization in both size and weight makes them ideal for aerospace microwave systems where they can be used to interconnect one input and two outputs or two inputs to one output. The 3-port unit is also used as a miniature isolator by terminating one of the ports with a load. Low insertion loss of these devices is also a prime factor for their use with parametric amplifiers.

Circle No. 227 on Subscriber Service Card

Thermal Insulation

An all-metal insulation, Metal K, has been developed by Johns-Manville for applications where a non-absorptive, cleanable insulation is desired. It is basically a reflective insulation with a variety of available construction and conductivities, and is job-engineered for specific applications. It can be fabricated in stainless steel, aluminum, or almost any metal.

Circle No. 228 on Subscriber Service Card

Lead Screw Fabrication

Helitronics Corp. announces a new concept in lead screw fabrication for missile, electronic, and engineering needs.

One for of this revolutionary long-axial-lead-per-revolution component exercises 14 starts an a 0.265-in.-dia. shaft, with a precision thread flow engineered to eliminate backlash, slipping, and jamming.

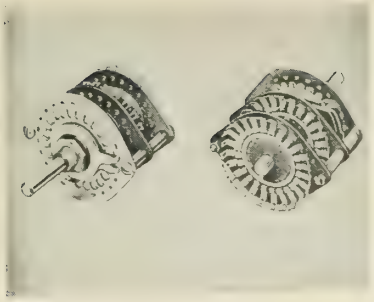
These units are currently utilized in measuring equipment, missile components, servo units, potentiometers, long continuously variable video delay lines, and many others.

Circle No. 229 on Subscriber Service Card

Recorder/Reproducer

A solid-state 14-channel magnetic tape recorder/reproducer system designed to handle a broad range of data storage problems in fixed base, mobile, industrial, and military applications has been announced by the Data Recorders Div. of Consolidated Electrodynamics Corp., a subsidiary of Bell & Howell Co. The 14-channel record/reproduce system is housed in a single vertical EMA cabinet 73¼ x 23 in. x 24¾ in. A tape speed control servo is used to compensate for low-frequency variations in the tape speed introduced between recording and reproduction of data.

Circle No. 230 on Subscriber Service Card



24-Position Switches

A line of 24-position switches, meeting the specifications of MIL-S-3768A, is now available from Centralab, The Electronics Div. of Globe-Union Inc. Switch sections are 1-31/32 in. by 2-5/16 in. with 2-in. strut centers. Operating range is −65°C to +85°C.

Designated the PA670 series, the switches utilize a double-ball dentent indexing mechanism with a "hill-and-dale" index plate to assure positive indexing of the contacts under extreme environmental conditions.

Circle No. 231 on Subscriber Service Card

Silicon Rectifiers

Immediate availability of 1000 and 1200 PIV hermetically sealed axial lead top-hot (DO-1) silicon rectifiers has been announced by Columbus Electronics Corp., Types IN3486 at 1000 and IN3487 at 1200 PIV are rated at 400 mA at 25°C ambient, 200 mA at 100°C ambient, maximum reverse current 2uA at rated PIV at 25°C ambient.

Circle No. 232 on Subscriber Service Card

Microwave Preselectors

Packaged, tunable microwave preselector filters, for four frequency ranges between 850-10,000 MC, are available from Empire Devices, Inc. They permit separation of wanted signals from high-amplitude interference for receivers or measuring instruments whose own selectivity is inadequate for the purpose. A direct-reading dial is incorporated for operator convenience.

Circle No. 233 on Subscriber Service Card



contracts

AIR FORCE

$13,841,000—**Boeing Co.**, Seattle, for production of missiles and related equipment.

$11,190,000—**American Machinery & Foundry Co.**, Greenwich, Conn., for work on the *Titan I* ICBM launching system.

$10,000,000—**Martin Marietta Corp.**, Baltimore, for research and development for the *Titan II* weapon system (supplemental contract).

$9,000,000—**General Electric Co.**, Cincinnati, for continued work on a "classified" project.

$8,792,278—**Hughes Aircraft Co.**, Culver City, Calif., for three models of the *Falcon* missile (3 supplemental contracts).

$7,381,000—**Lockheed Aircraft Corp.**, Burbank, Calif., for production and component improvement of *Agena* space vehicles (2 supplemental contracts).

$6,907,807—**Thiokol Chemical Corp.**, Bristol, Pa., for missile rocket motors for *Sergeant, Pershing* and *Nike-Hercules*.

$5,984,802—**Lockheed Aircraft Corp.**, Burbank, for research and development of a satellite control subsystem.

$5,850,000—**Aerojet-General Corp.**, Sacramento, Calif., for research and development work on stage two rockets for *Minuteman* missiles.

$4,887,097—**North American Aviation, Inc.**, Los Angeles, for spare parts for *Minuteman* guidance and control systems.

$4,500,000—**Space Technology Laboratories, Inc.**, Redondo Beach, Calif., for systems engineering and technical direction for *Atlas, Titan* and *Minuteman* missiles.

$4,498,000—**General Electric Co.**, Syracuse, N.Y., for work on air weapons control systems.

$3,662,372—**Martin Marietta Corp.**, Baltimore, for activation work on *Titan* ICBM bases at Ellsworth AFB, Idaho, Larson AFB, Wash., Mountain Home AFB, Idaho, and Beale AFB, Calif. (supplemental contract).

$3,000,000—**Radio Corp. of America**, Moorestown, N.J., for work on the BMEWS system.

$2,400,000—**General Electric Co.**, West Lynn, Mass., for development and production of a *Titan II* re-entry vehicle.

$2,400,000—**Avco Corp., Lycoming division**, Stratford, Conn., for *Titan II* re-entry vehicles.

$2,230,000—**Aerojet-General Corp.**, Sacramento, for Stage II *Minuteman* solid-propellant rocket motors, ground support materials and related materials (supplemental contract).

$2,000,000—**North American Aviation, Inc.**, Canoga Park, Calif., for *Atlas* propulsion systems (supplemental contract).

$1,950,000—**Ford Motor Co.**, Detroit, for design, development, fabrication and testing of subsystems for *Atlas* and *Titan* missiles.

$1,713,726—**United Electrodynamics, Inc.**, Pasadena, Calif., for work on a classified project (supplemental contract).

$1,666,747—**Budd Electronics, Inc.**, Long Island City, N.Y., for modification of gap filler radars (supplemental contract).

$1,377,000—**United Electrodynamics, Inc.**, Pasadena, for work on a classified project.

$1,237,000—**Ralph M. Parsons Co.**, Pasadena, for a study program for a *Minuteman* subsystem (supplemental contract).

$1,197,000—**Lockheed Aircraft Corp.**, Burbank, for *Agena* space vehicles (supplemental contract).

$1,150,000—**Minneapolis-Honeywell Co.**, for work on the *Dyna-Soar* guidance subsystem. Work to be done in St. Petersburg, Fla.

$600,000—**Brooks & Perkins**, Detroit, for the light metal structure of the inertial guidance computer and navigation of the *Minuteman* missile.

$380,000—**Sylvania Electric Products, Inc.**, Buffalo, for design and development of a feasibility model of an advanced space communications set for use in second-generation aerospace vehicles.

ARMY

$3,095,180—**Flightex Fabrics, Inc.**, Brockton, Mass., for M-72 rocket launchers.

$1,995,000—**FMC Corp.**, San Jose for 75 missile carriers for the *Pershing* missile.

$1,985,690—**Pomona Division of General Dynamics**, for continued research and development work on the *Redeye* air defense guided missile.

$1,150,000—**General Electric Co.**, Syracuse, for repair parts on HIPAR on the improved *Nike-Hercules*.

$650,000—**The Garrett Corp., AiResearch Manufacturing Div.**, Phoenix, Ariz., for small gas turbine generator sets for the *Sergeant* missile launching system.

$368,055—**Intercontinental Manufacturing Co.**, Garland, Tex., for components of *Nike-Hercules* sustainer motor.

$340,000—**Douglas Aircraft Co.**, Charlotte, N.C., for metal working machinery for *Nike-Hercules* missile system.

NASA

$17,000,000—**Aerojet-General Corp.**, for design and development of the M-1 engine for use in the *Nova* space vehicle. Work to be done at the George C. Marshall Space Flight Center at Huntsville, Ala.

Associated Testing Laboratories, Inc., Wayne, N.J., for preflight evaluation of both semiconductor and component parts for guidance and control equipment of the *Saturn* booster series. Work to be done in Wayne, N.J., and Winter Park, Fla. (undisclosed amount).

DOD

$3,000,000—**Cubic Corp.**, San Diego, for advanced electronic equipment for tracking missiles.

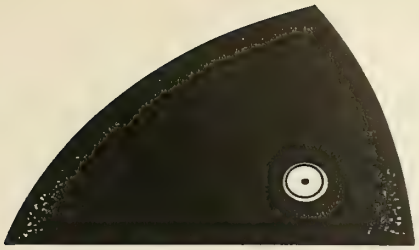
$1,700,000—**General Dynamics Corp., Astronautics Div.**, San Diego, for instrument pods for missiles.

INDUSTRY

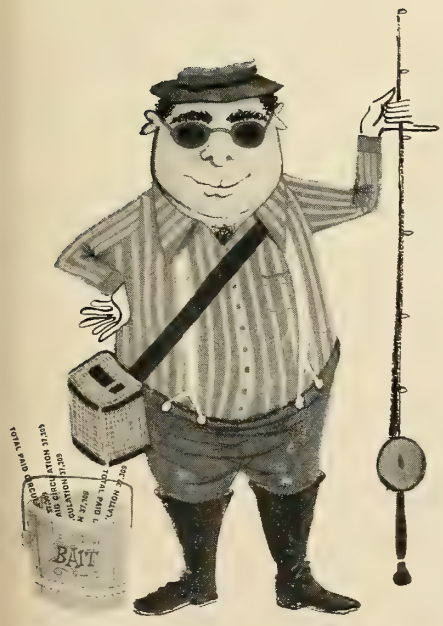
IBM Corp., Rockville, Md., from **McDonnell Aircraft Corp.**, for development of an advanced electronic guidance computer for the *Gemini* spacecraft (undisclosed amount).

Collins Radio Co., Dallas, from **North American Aviation**, for telecommunication system for the *Apollo* spacecraft (undisclosed amount).

Detroit Designing & Engineering Co., Downey, Calif., from **North American Aviation Autonetics Div.** for six *Minuteman* test consoles (amount undisclosed).



Ask any good angler. He'll tell you it's not luck. The big ones are caught with the right bait. MISSILES AND ROCKETS, the Weekly of Space Systems Engineering, has the bait – editorial written specifically for the missile/space industry. Editorial designed to land the big ones. Don't be a luck angler. Advertise in MISSILES AND ROCKETS to reach all the important missile/space buying influences without a snag.



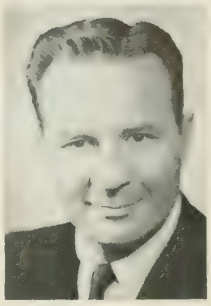


IT'S THE BAIT THAT COUNTS

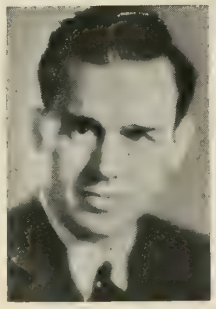
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names in the news


HARRINGTON


MONROE


HASTINGS


THOMAS


GUNST

William M. Ellsworth: Promoted to vice president of PneumoDynamics Corp., Washington, D. C.

Dr. Walter E. Crandall: Appointed director of research for Northrop Corp., Ventura, Calif. division.

T. F. Hardman: Appointed engineering manager of the Westinghouse Electric Corp., X-ray division, Baltimore.

Edgar W. Harrington: Appointed district manager, Boston area, for Sylvania Electronic Systems.

Dr. Gerald H. Monroe: Named program director, lunar systems, for Martin Company's space systems division at Baltimore.

Julius Marymor: Appointed director of defense contracting for Consolidated Systems Corp., Monrovia, Calif.

J. L. Bromberg: Appointed vice president of missile and space systems division and director of *Skybolt* program of Douglas Aircraft Co., Santa Monica, Calif.

Edward M. Owen: Appointed Washington, D. C., representative of Fairchild Stratos.

Dr. S. K. Ghandi: Research manager for electronic components and function, Philco Corp., Philadelphia, chosen chairman of the Program Committee of the 1963 International Solid-State Circuits Conference.

Vincent Barreca: Elected president of Admiral Corporation, Chicago. Former president **Ross D. Siragusa, Sr.,** continues as chairman of the board and chief executive officer.

Arthur J. Schmitt: Founder and chief executive officer of Amphenol-Borg Electronics Corp., Broadview, Ill., elected founder-chairman of the company. **Matthew L. Devine,** re-elected president, will also serve as chief executive officer.

A. H. Jackson: Named vice president-general manager of newly established Advanced Products Division of Blaw-Knox Co., Pittsburgh.

Rex H. Madeira: Executive vice president, Page Aircraft Maintenance, Inc. Fort Sill, Okla., elected president of the National Aeronautical Services Assn., and **Charles G. Gulledge,** president of Dynaelectron Corp. Washington, D. C., elected vice president. **Harry S. Baer, Jr.,** was re-elected secretary-treasurer.

Norman L. Winters: Appointed manager of Motorola's Chicago military electronics division.

Richard E. Hastings: Appointed vice president and general manager of General Precision, Inc., commercial computer division in Tarrytown, N. Y.

Dr. Jay Tol Thomas: Appointed director of the newly established Siegler Research Laboratories, Los Angeles.

Joseph B. Arnold: Named manager of the *Minuteman* program office at the reconnaissance systems laboratories of Sylvania Electric Products, Inc., Mountain View, Calif.

Allan A. Harris: Elected vice president of TransDynamics Corp., Palo Alto, Calif.

Edward DeLaney: Named head of Astrosystems, Inc., space physics department. **Victor Oburg** joined the company as project engineer.

Howard F. Thames: Appointed manager of Sperry Gyroscope Company's new Huntsville, Ala., office.

Morgan A. Gunst, Jr.: Elected president of Quantic Industries, Inc., San Carlos.

Carl P. Clare: Chairman of the board and president of C. P. Clare & Co., Chicago, elected a director of Amphenol-Borg Electronics Corp. **Dr. William L. Everitt** of the University of Illinois College of Engineering, also elected a director.

H. W. Hanley: Appointed general manager of the Montrose division of The Bendix Corp., Montrose, Pa.

James C. Callaghan: Elected vice president of Packard Bell Electronics, Los Angeles.

Kuchen Shen: Appointed chief engineer of the advanced development section of Vitro Corporation of America, Silver Spring, Md.

Ellis C. Maxcy: Elected a director of United Aircraft Corp. He is president of Southern New England Telephone Co.

Gordon S. Humphrey: Appointed general manager of the Leach Controls Div., Azusa, Calif. He is former head of Raytheon Corp.'s Santa Barbara Operation.

Dr. Cameron Knox: Elected a vice president of Acoustica Associates, Inc., Los Angeles. He was corporate director of research for the company.

T. W. Sheppard: Named head of a new Fleet Systems Div. in the *Bumblebee* program at Johns Hopkins Applied Physics Lab. He is former head of APL's *Tartar* missile development.

Dr. Aram K. Hampikian: Appointed technical director of Sperry Rand Corp.'s Sperry Semiconductor Div. He comes to Sperry from Minneapolis-Honeywell Regulator Co., Boston.

Leon Himmel: Elected an assistant vice president of ITT Federal Labs, Nutley, N.J. He will assist in directing engineering, manufacturing and sales operations of the labs.

Eugene G. Dowd: Appointed General Manager of the G. S. Marshall Co., San Marino, Calif.

Joseph D. Hurley: Named planning manager for Raytheon Co.'s Semiconductor Div. He will be responsible for establishing and maintaining short- and long-range financial, product and market objectives and plans.

Dwight W. Hunt: Named comptroller for Bendix Computer Division. He has been divisional comptroller of the Bendix Corp.'s Filter Div. since 1947.

George R. Gehrkens: Named executive vice president, North American Aviation's Columbus Div. He succeeds **Richard F. Walker,** recently named a vice president of NAA's Space and Information Systems Div. and general manager of the division's new Tulsa, Okla., facility.

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American Institute of Electrical Engineers, Empire Tri District Meeting, Lawrence Hotel, Erie, Pa., May 14-16.

Society for Experimental Stress Analysis, Sheraton-Dallas Hotel, Dallas, May 16-18.

Annual Meeting and Conference of Aviation/Space Writers Association, Mark Hopkins Hotel, San Francisco, May 20-26.

ASME Hydraulic Conference, Bancroft Hotel, Worcester, Mass., May 21-23.

8th National Aero-Space Instrumentation Symposium, sponsored by The Instrument Society of America, Marriott Motor Hotel, Washington, D.C., May 21-23.

1962 National Telemetering Conference, Sheraton Park Hotel, Washington, D.C., May 23-25.

American Society for Quality Control Annual Convention and Exhibit, Netherland-Hilton Hotel, Cincinnati, May 23-25.

International Space Aerorama, Miami, Fla., May 25-27.

The First Annual Convention of the American Association for Contamination Control, Jack Tar Hotel, San Francisco, May 28-30.

JUNE

Society of Technical Writers and Publishers Annual Meeting, Sheraton Hotel, Philadelphia, June 6-8.

Cornell University Seminars in Industrial Engineering Operations Research and Statistics, Ithaca, N.Y., June 12-15.

National Society of Professional Engineers, French Lick Sheraton Hotel, French Lick, Ind., June 13-16.

American Nuclear Society Annual Meeting, Statler Hilton Hotel, Boston, June 17-21.

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Go Home, Russian

WE ARE FED UP with the propaganda tour of Maj. Gherman S. Titov.

One more newspaper story about the boyish and embarrassed enthusiasm of the Soviet cosmonaut surely will lead to our own earthbound version of orbital seasickness.

He is one of the most evasive Soviet propagandists we have encountered in some years of dealing with the Russians. It has been our fortune in the past to have talked with Khrushchev, Bulganin, Malenkov and others. When it comes to Soviet double-talk, they can't hold a candle to the hero of *Vostok II*.

Boyish may be one word to describe Maj. Titov. But after listening to his unresponsive replies, his disparaging remarks about New York City, and his derogatory comments on the U.S. space program, we think obtuse might be a more apt adjective.

It was evident the Russian visitor was poorly briefed for his American excursion. He most definitely was out of his element in his encounters with the U.S. and foreign press here. The feeling he left behind was one of strong antagonism.

Titov's refusal to answer straightforward questions was not lost on members of the foreign press corps. In fact, his visit may in the long run do considerable damage to Soviet efforts to build up prestige in the space field.

Many observers who did not question Maj. Titov's orbital accomplishment now are beginning to wonder out loud if he actually made the flight.

One interesting incident in this connection came during the tour of the Smithsonian Institution by Maj. Titov and American astronaut Lt. Col. John Glenn.

Col. Glenn had been only a perfunctory guide until the pair reached the *Freedom 7* capsule in which Alan Shepard made his suborbital flight. This was a subject Glenn knew well, and he began a detailed explanation of the capsule.

Normally, one would have expected quite a flow of knowledgeable questions from the Soviet cosmonaut. Instead, Titov clammed up. He had no questions about the various systems or controls. His only comment was a passing remark about the small size of the *Mercury* capsule. An odd reaction for an experienced cosmonaut.

Some of Titov's press conference discourses were prompted by stupid questions from inept reporters who should have known better. We don't think the Soviet major's views on God, religion, and the rising of war in the hearts of men are of particularly pertinent interest. Fortunately, such questions were in the minority.

Not that it mattered much. Efforts to pin the Russian down on commonplace details of the Soviet space program resulted in lengthy propaganda speeches about disarmament. He refused to discuss Russian boosters because of military applications. We can understand that view.

But he used the same reason for not discussing the space capsule. When the discrepancy was pointed out to him, he waved questions aside as of "no principal importance."

When Col. Glenn himself expressed interest in a specific question about the *Vostok* spacecraft, Titov again lapsed into vagueness. His attitude left many of the reporters furious.

Part of his apparent boorishness probably can be traced to the Soviet doctrine which allows for no such animal as a free press. The press in the Soviet Union is regarded as an instrument for the education of the people to the benefit of the government. Answers are not provided to unwanted questions.

That was precisely Maj. Titov's attitude in his U.S. press conferences.

"If you've listened to Titov for three minutes, you've listened to him for three months," commented one reporter. "He's said all he's going to say."

IT IS NOT Titov's reluctance to share information on the Soviet space program that angers us, however. It is his sarcastic, patronizing propaganda snow-job. New York is a drab city. American streets are too jammed with cars.

We lived in Moscow, Maj. Titov. Don't talk to us about drab cities. We also know that most Russians would be delighted to have enough automobiles to create a few traffic jams. Stick to astronautics and leave the propaganda to the experts.

We would prefer to hear some convincing, informative discussion of the truly worthwhile Soviet accomplishments in space.

We do not want to close this tirade without three resounding cheers for John Glenn. When Titov attempted to use his platform before the world press to link release of space information with disarmament, Col. Glenn interrupted to put the U.S. position clearly on the record: We make the information available right now.

The American astronaut made the point clearly and with telling effect.

We recommend that Maj. Titov and his superiors spend some time pondering it before undertaking another such propaganda debacle.

William J. Coughlin



ROCKETRY...FROM KAI-FUNG-FU TO THE MOON

From the first-known use of rockets in the defense of Kai-fung-fu in 13th century China, rocketry has experienced anything but a continuous advance. For many hundreds of years these early fire arrows knew little improvement or new missions. Gradually they were given minor applications as signaling devices, incendiary weapons and lifeline launchers. Suddenly, in the last three decades, rocketry has made its breakthrough as a spectacular source of power.

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MAY 21, 1962

missiles and rockets

THE WEEKLY OF SPACE SYSTEMS ENGINEERING

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THE COVER

Target of NASA's huge Apollo program expected to cost from $20-35 million by 1970 is to land three men on the moon—if possible by 1957. M/R's special report on Project Apollo starts on p. 16.



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The Missile/Space Week

Late Mercury Developments

NASA has scheduled a new physical examination for Astronaut Donald K. Slayton.

This will determine whether Slayton is sufficiently recovered from a minor heart disturbance to perform manned spaceflight missions.

Slayton was to have been the prime pilot for the *MA-7* flight scheduled for Saturday, May 19. He was replaced by Astronaut Scott Carpenter when it was revealed he suffered from minor heart tremors.

Space agency officials said at that time that if the condition improved Slayton would again be eligible to take part in the *Mercury* and follow-on U.S. manned space flight program.

Meanwhile, reports of bad weather in the Atlantic Ocean recovery areas opened the possibility that America's second manned orbital space flight might be delayed until sometime in the week of May 21.

The three-orbit space flight was to almost duplicate the flight of Astronaut John Glenn last Feb. 20. Carpenter, however, was scheduled to perform a series of new experiments (M/R, May 14, p. 14).

Centaur Troubles Explained

NASA acknowledged before a House Space Subcommittee last week that there have been deficiencies in the *Centaur* program.

The space agency insisted, however, that these have been corrected and the launch vehicle project is now on a sound basis.

The officials attributed the *Centaur* problems to a too-austere budget at the start, growing pains of a new organization, and unexpected technical difficulties in utilizing high-energy liquid hydrogen as a rocket fuel.

Centaur is now about 15 months behind its original schedule following the failure of the first launch on May 8. It originated as an Air Force Project in 1958, but was shifted to NASA in mid-1959. Technical direction, however, remained in the hands of the Air Force.

Dr. Wernher von Braun, director of the Marshall Space Flight Center, told the subcommittee that there had not been "sufficiently intimate liaison" between the Air Force technical team and the space agency's rocket center.

The Center was given technical responsibility for the project in June, 1960, but the AF team remained in Los Angeles.

Von Braun told the subcommittee that NASA has recommended several times, starting early in 1961, that the Air Force team be shifted to Huntsville, Ala. The Air Force rejected the idea because the contract was being administered by one of its Los Angeles offices.

He said that assignment of the Air Force team to Marshall would have permitted more technical support, and thus "we would have provided more protection against delays and difficulties."

Von Braun said that while the definite cause of the May 8 failure has not yet been determined, preliminary indications pointed to a "structural" failure of the insulation panels protecting the supercooled hydrogen fuel tank against aerodynamic heating.

Movies taken as the *Atlas-Centaur* exploded at 25,000 ft. altitude indicate that one of the panels ripped off starting about 40 sec. after launch.

Dr. Homer E. Newell, director of the Office of Space Sciences, said many *Centaur* problems may be traced to its expansion from a "financially austere, low-priority experiment in liquid hydrogen for space use" into a major vehicle program.

"Taming liquid hydrogen to the point where expensive operational space missions can be committed to it has turned out to be more difficult than anyone supposed at the outset," he said.

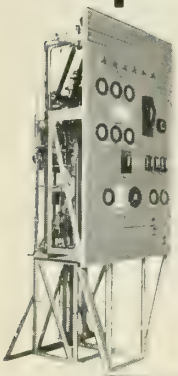
NASA said the latest schedule is for a second *Centaur* attempt in October, a third launch before the end of the year, and the remaining seven to be completed by early 1964. Newell admitted that this is a very tight schedule, but said that "we will make every effort to meet it."

Newell said that NASA will concentrate on solving the intermediate bulkhead heat transfer problem which caused the explosion in the first *Centaur* flight.

In addition, he said *Centaur* will be changed to accommodate only two engine firings in flight rather than three, relieving the vehicle of a six-hour coast between second and third burnouts on the *Advent* missions.

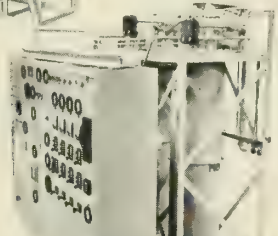
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ASROC Warhead Tested

In the eighth blast of the current U.S. nuclear test series (Operation Dominic) being conducted in the Pacific, the AEC has reportedly detonated an *ASROC* warhead.

Scheduled to be installed aboard 95 Navy destroyers and 35 guided missile frigates, Minneapolis-Honeywell's *ASROC* will provide the fleet with a long-range (about eight miles) surface-to-underwater anti-submarine weapon.

Shots of the Week

• *ANNA* — a geodetic satellite equipped with a flashing light beacon and other instruments to increase the accuracy of measurements of the Earth's surface—failed to achieve orbit when the booster second stage failed May 10 after launch from Cape Canaveral.

Failure of the *Thor-Able-Star* second stage to ignite was blamed on a faulty relay between the first and second stages.

The 355-lb. satellite—only recently declassified by DOD—is scheduled for a second launching later this year using the same booster.

• A "partially successful" test of the Army's *Nike-Zeus* antimissile missile was conducted May 9 from Pt. Mugu, Calif.

• The Air Force was completely successful with a 3600-mile flight of its solid-fueled, underground-launched *Minuteman* ICBM, May 11. Launched from Cape Canaveral, the shot was a complete test of the operational system.

• A secret satellite was launched by the Air Force May 15 from Vandenberg AFB, Calif., using a *Thor-Agena B* combination.

NASA Authorization Trimmed

The House Space Committee has slashed $116 million from NASA's $3.79-billion Fiscal 1963 authorization bill.

The reduction in authorized expenditures over the next fiscal year was concentrated in the Office of Manned Space Flight and scientific satellite and lunar spacecraft programs (M/R, April 16, p. 14).

The heaviest axe fell on the $357-million request for the lunar mission launch sites at Cape Canaveral. The committee voted to cut $63.6 million from the *Nova* launch complexes. Also included in the $82.7 million cut from Manned Space Flight: $5 million for facility planning, $11.5 million for static test stands for *Nova* at the Mississippi test facility, and a $1-million reduction in Project *Mercury*.

The committee also cut the scientific satellite and lunar spacecraft funds requested by $33.4 million. The *Prospector* program was killed completely when the committee refused to approve its $10-million request.

McClellan Raps Douglas

In a prepared statement for the re-opening of his hearings into profit pyramiding in missile/space contracts, Sen. John L. McClellan (D-Ark.) labeled "patently improper and unjustified" Douglas Aircraft Co.'s defense of profits made on *Nike-Ajax* and *Hercules* work.

Referring to a justification by Douglas of its contention that the company made $29.8 million profit—not $63.8 million as claimed by the committee, McClellan said company president Donald W. Douglas seemed "guilty of the same very 'gross distortion' charge which Mr. Douglas has once aimed at the staff of this committee."

Douglas promptly issued a statement defending his company's figures.

The earlier Douglas reply to the committee showed that the $34.1 million difference between its *Nike* "fee" and its "profit" was made up of: $23 million for the development of the DC-8, $2 million for the DC-7, -6 and -3 commercial aircraft, $4.41 million for interest, $1.24 million for amortization in excess of depreciation, $1.46 million for advertising and $1.78 million of miscellaneous expenses.

This attempt to charge expenses of "commercial endeavors of the company against his actual profit on the *Nike* missile production," McClellan said, "in an effort to diminish or conceal the true nature and extent of his missile profit, is patently improper and unjustified and cannot be approved or allowed to stand. The system of procurement which would permit the taking of profit in that fashion surely requires prompt revision and correction."

The answering statement by Douglas said his firm would "stand on those documents. We believe a careful reading of them supports the position we attempted to make clear in previous testimony, including the fact that the costs under discussion did not increase the prices paid us for our work under government contracts—and, in fact, operated to save the government money."

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120-in. Solid Fired at Lockheed

Lockheed Propulsion Company static-fired a 120-in. large solid motor May 12 as part of an Air Force advanced program on propellant technology.

The largest solid to be fired to date, the motor burned for more than 120 sec. and produced approximately 400,000 lbs. thrust.

Second Titan Squadron Ready

The second squadron of *Titan I* ICBM's has been declared operational by the Air Force at Lowry AFB, Colo.

The first *Titan* squadron, declared operational about three weeks ago, is also located near Lowry.

The 18-missile unit brings to 72 the number of operational ICBM's in the U.S. arsenal.

U.S. Urges Space Pact

U.S. Delegate Charles C. Stelle urged the 17-nation disarmament conference meeting in Geneva to take action to prevent space from becoming "another focus for the arms race."

Stelle told the delegates that the conference could "lead to measures designed to insure that outer space can become an impetus to man's peaceful progress and not a battleground in the future."

Under the U.S. plan, there would be international inspection of all space vehicles prior to launching. The plan also calls for ground-based and spaceborne instruments to detect unreported launches.

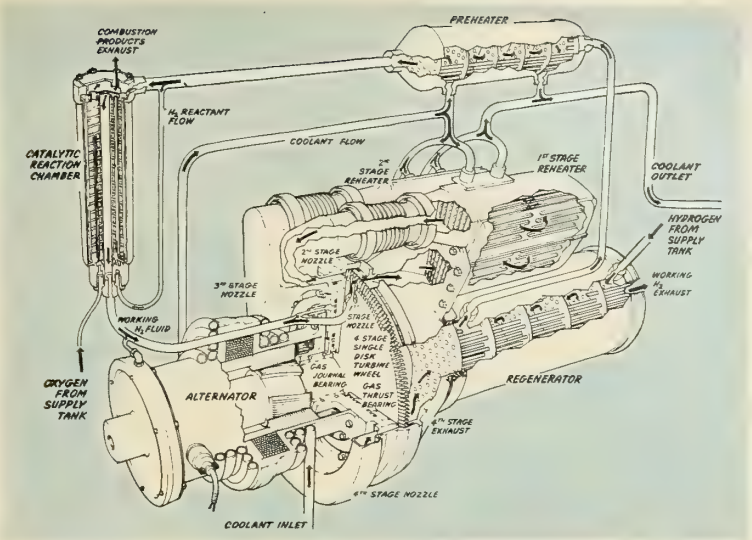
Although neither the U.S. nor Russia now plans to put nuclear weapons in orbit, Stelle said, the possibility of such action is "neither so immediate a problem as to be viewed with alarmist urgency nor so remote a problem that it does not warrant serious and timely preventive measures."

The Russian delegate, Valerian A. Zorin, had no immediate reply to the U.S. proposal.

ANNA may go to NASA

Under the prodding of the House Space Committee, DOD seems ready to transfer to NASA the management of the controversial Project *ANNA*—a geodetic satellite (see Shots of the Week) designed to provide much improved accuracy in worldwide mapping.

Testifying before the committee DDR&E Director Harold Brown admitted that the program amounted to basic scientific research and that DOD has recently taken steps to ex-



A SENSIBLE WAY TO PROVIDE ACCESSORY POWER IN SPACE VEHICLES

This is the Sundstrand CRYHOCYCLE . . . a cryogenically fueled, fully integrated power generation and thermal control system. Sundstrand developed the turbine driven CRYHOCYCLE under a U.S. Air Force Systems Command contract. Powered by hydrogen and oxygen, the CRYHOCYCLE is unique in that normally wasted heat from energy conversion inefficiencies and even metabolic heat from the crew is recovered by the coolant loop and returned to the power cycle by interstage reheaters between each of the four stages of a single-disc turbine. Sundstrand has also developed a multi-stage reciprocating version of the CRYHOCYCLE for low power levels. This concept results in specific fuel consumption economy which has not been achieved by any other dynamic space power system. As a result fuel weight and volume are reduced. In addition, the CRYHOCYCLE operates at room temperature eliminating need for high temperature materials, solving wheel containment problems, and greatly improving inherent reliability and safety. Since the CRYHOCYCLE is independent of the environment, it is ideal for Lunar missions. ■ The CRYHOCYCLE is a sensible size, too. About the size of a gasoline lawn mower motor, it can be used in pairs for maximum reliability. ■ Several versions of this space power system are being developed which will be suitable for missions of several weeks' duration . . . at power levels from one kilowatt to 50 kilowatts. Both the turbine prime mover (shown) and the reciprocating machine have been publicly demonstrated to representatives of the aerospace industry and government service. ■ (A simple request on your business stationery and we will send you details concerning this and the other accessory space power systems which Sundstrand has under development.) ■ If you would like to work on the Sundstrand Engineering team in the development of practical solutions to challenging space power problems, write to: Personnel Director,

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pand *ANNA* into an international program.

Noting that funds were available for only two launchings, Brown assured the committee that DOD would reprogram funds adequate to achieve a successful launch.

A follow-on program being discussed with NASA calls for six launches over a three-year period at a cost of approximately $70 million. The feasibility phase of the program, as funded now, will cost about $12 million, Brown said.

McCloy asks Space Cooperation

John J. McCloy, chairman of the General Advisory Committee to the United States Arms Control and Disarmament Agency, urged European nations to forgo their aspirations to become a third space power and to cooperate more closely with the U.S. in space exploration.

Speaking before delegates to a four-day conference on "Outer Space: Prospects for Man and Society," in Brighton, England, McCloy reasoned that such cooperation would cause the Soviets to moderate their policies.

From contacts with the Russians, he said, he had "the strong impression that once those leaders sensed a united position on the part of the West, they are prepared to moderate their policies accordingly."

At another session, U.S. defense experts suggested that one of the four satellites recently launched by Russia may be a reconnaissance vehicle.

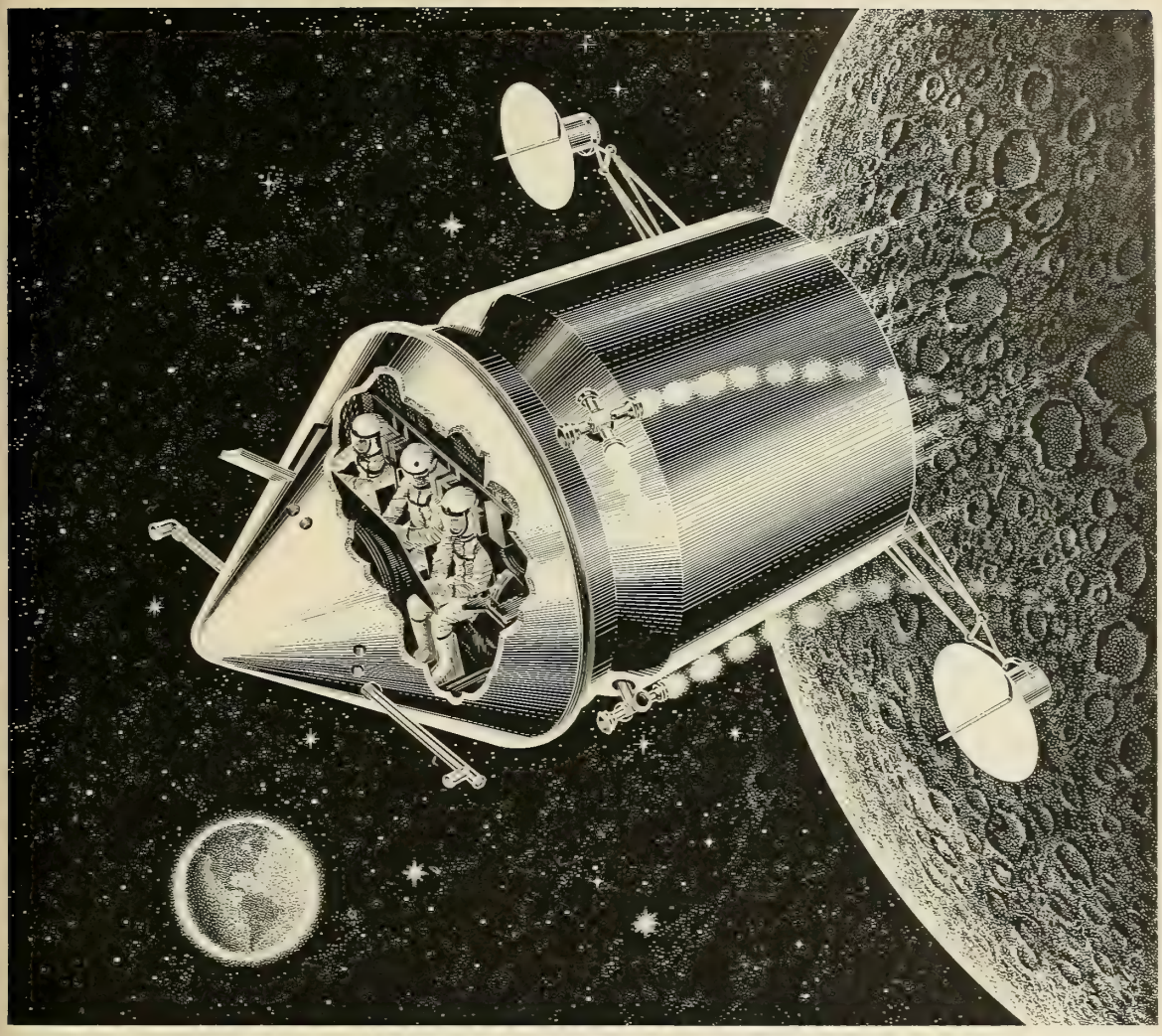
Noting that the USSR has never protested the U.S. *Samos* satellites, a U.S. spokesman opined that the Soviets might use orbital reconnaissance craft for observation of Red China and keeping track of movements of the West's naval forces.

The conference was sponsored jointly by the American Assembly of Columbia University and the British Institute for Strategic Studies.

COSPAR Sets Up Space Panel

The 18-nation Committee on Space Research (COSPAR) wound up its ten-day meeting in Washington by voting to establish an international panel to preclude "potentially harmful" experiments from being conducted in space.

Prompted by a resolution passed last year by its parent organization —the International Council of Scientific Unions, the panel will be comprised of six scientists who will recommend action the scientific community can take against harmful space experiments.



IN AEROSPACE, MARQUARDT MEANS . . .

Reaction control engines for Project Apollo

Marquardt has been selected by North American Aviation to supply the reaction control rocket engines for Project Apollo—America's initial manned expedition to the moon. Marquardt engines will be used in the crew's command module and the service module of the spacecraft as part of the flight and stabilization control system. In the service module the engines will supply attitude control and stabilization enroute to the moon and back and during lunar and earth orbit, while command module engines will provide stabilization and attitude control during re-entry into the earth's atmosphere.

Marquardt has successfully designed and built advanced control systems for aerospace vehicles for nearly two decades. Absolute reliability and precise accuracy are necessary for satellite rendezvous, station keeping, orbit control, landing and lift-off from distant planets. Reaction control systems by The Marquardt Corporation are relied on to do these vital jobs.

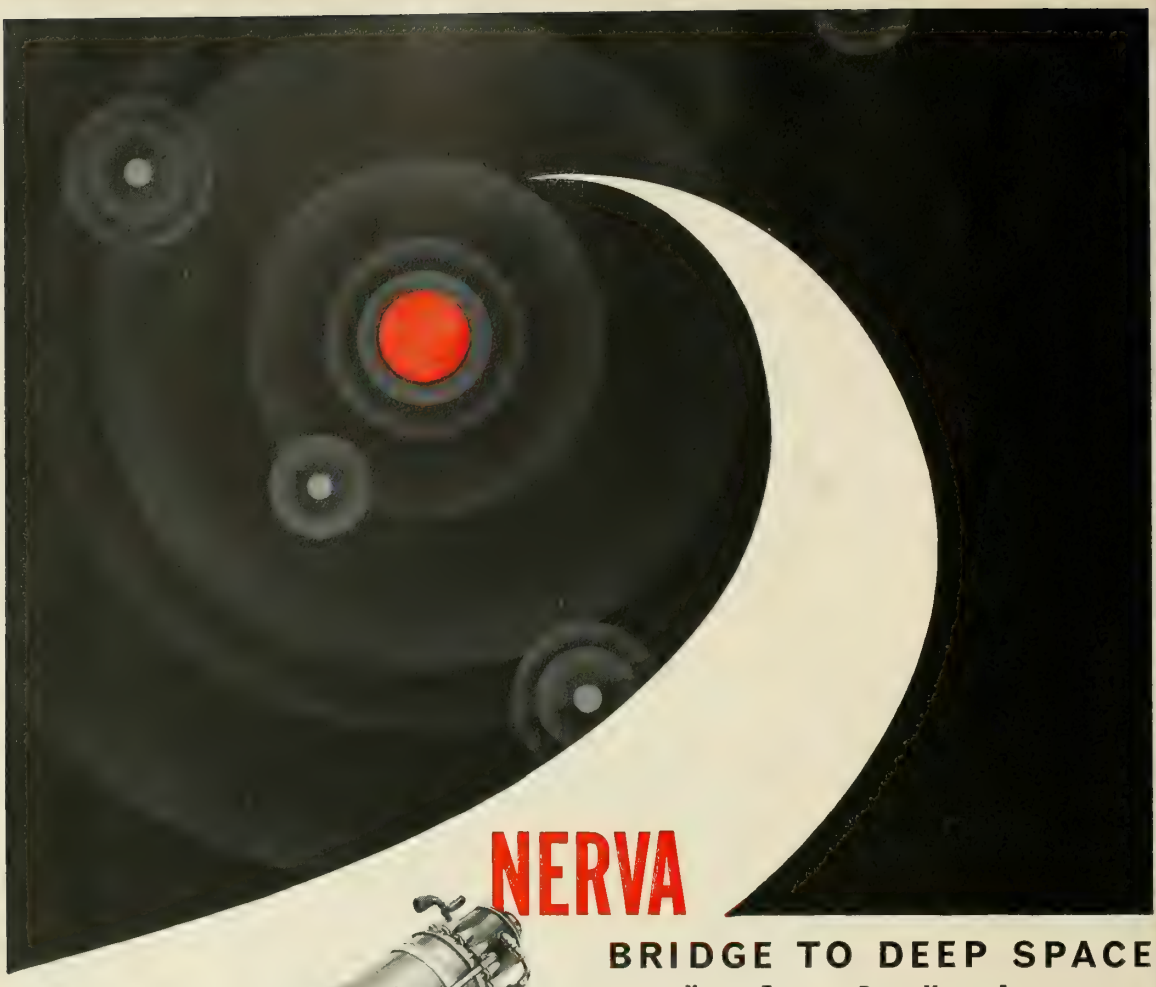
Engineers and scientists interested in joining Marquardt on Apollo and other significant aerospace projects are invited to direct résumés to Professional Personnel at address below.

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The Countdown

WASHINGTON

Centaur Replacements Considered

NASA is considering two launch vehicles to replace *Centaur* on some of its missions. The *Saturn C-1* would be used for some high-altitude flights, while the *Titan II* with a third stage is being considered for lower orbital missions.

Telstar Launch Date Set

First launch of *Telstar* now is scheduled for June 12. A backup will be ready in July or early August if needed.

Stratoscope May Not Go Until January

October launching for the *Stratoscope II* balloon-mounted telescope now in final assembly at Perkin-Elmer Corp. is considered a long shot. January is seen as a more realistic date. Reason: Lack of ground support facilities at the Palestine, Tex., launch site. Change of launch date for the 600-ft. balloon and its 6000-lb. payload could mean a switch in its optical target from Venus to Mars.

NASA Officials Backing Aerospace Plane

NASA officials at Marshall Space Flight Center believe development of *Aerospace Plane* is a must if economical space flight is ever to be achieved. Its biggest economic advantage is that it could be recovered and used many times.

Minor Part Blamed for Skybolt Failure

Failure of the second stage to ignite in the first flight test of the Douglas *Skybolt* is blamed on a minor component. A malfunction in the safeing and arming device reportedly prevented the second stage from receiving the ignition signal.

New Engine Seen for Re-sized Nova

If the program review under way in NASA decides against direct ascent for the *Apollo* lunar landing mission, *Nova* may be optimized for another mission, probably a manned expedition to Mars. For such a mission, NASA planners feel a new engine, generating 6-8 million lbs. thrust, will be required.

More Realistic View of DOD Contracts

Congressional opposition to use of defense contracts for welfare purposes is growing. A ranking Republican member of the House Appropriations Committee asserts that DOD should not be used as a massive WPA subject to social pressures. He says Congress is becoming convinced that DOD has a big enough job without such added problems.

INDUSTRY

A Close Watch on Incentive Contracts

Industry representatives at the recent Air Force Systems Command management conference in California expressed concern that incentive contracting might become a military fad. Incentive contracts are useful in the right place, they warned, but are not always the most desirable choice.

New Space Radar Under Development

Engineers at the Electronic Tube Div. of Sperry Rand Corp. are confident a series of three extremely high-frequency millimeter-wave length traveling wave tubes now under development for the AFSC Electronic Technology Laboratory could make up the guts of a spaceship-to-spaceship radar communications system. Two of the tubes form an amplifier chain which is designed for 50-kw. peak RF power output at 55-gc. with an input of only 1-kw. The third tube, a two-helix TWT about 8 in. long, provides the low-noise receiver capability at the same frequency.

NASA Planning In-House Systems Engineering

One of NASA's biggest personnel needs is for more systems engineers. The space agency expects to start a recruiting drive in the near future to fill the many vacancies. On the success of the drive hang NASA plans to do all systems engineering work in-house in the future.

INTERNATIONAL

Dates Set for Next French Aerospace Show

Dates for the next Paris aerospace show at Le Bourget under sponsorship of the French Aerospace Industries Assn. (USIAS) have been announced: June 6-16 of 1963.

Greeks Seeking U.S. Rockets

Greek government backing is expected for a plan by the Greek Scientific Rockets Research Group on Space to buy high-altitude solid sounding rockets from U.S. firms.

Swedish Space Group Formed

A Swedish industrial space research group has been formed in Stockholm. Among those participating: Saab Aircraft Co., Telefon AB LM Ericcson, Svenska Flygmotor AB and Svenska AB Gasaccummultator (Aga). The group has been formed as a branch of the Sveriges Mekanforbund, a general industrial organization, with the aim of studying peaceful applications of space research.

Anglo-Dutch Electronics Tieup

Two of Britain's biggest electronics firms—Electrical & Musical Industries Ltd. (EMI) and Philips Electrical Industries Ltd., a subsidiary of the Dutch firm—are to merge their manufacture of magnetic recording tape. Each will hold 50% of the shares of a new company which will be formed. Existing EMI and Philips tape factories will continue in production, but a new plant is to be built—probably at Hayes, Middlesex.

Collins communications careers point UP

Every American voice from space — from the X-15 and Mercury — has been carried by Collins communications. Now, with the accent on reliability, Collins is readying extensive systems for the next and most ambitious U.S. space effort, NASA's Apollo manned lunar spacecraft. ☐ To further extend this leadership in space communications, Collins requires specialists in HF, VHF, UHF equipment, digital communications, spacecraft antennas, TV, radar, modulation techniques, tracking and ranging, information theory, and ground systems. If interested in this challenge, write Mr. L. R. Nuss, Cedar Rapids, Iowa; Mr. C. P. Nelson, Dallas, Texas; Mr. E. Montano, Newport Beach, California.



A Special Report on Project Apollo

JUST A YEAR AGO, almost to the day, President Kennedy presented to Congress the ambitious Administration plan to beat the Russians to the moon. Progress since then has not been at a pace to satisfy all of those concerned with the Manned Lunar Landing program.

There have been a number of delays. The program first had to wait on Congressional appropriation of the money requested as a presidential add-on to the Fiscal 1962 budget. This was followed by the extensive reorganization of NASA last November which brought D. Brainerd Holmes into the project as moon boss. The current systems engineering review has resulted in further delay.

July 1 now is named as the date for the technical go-ahead on the project—more than 13 months after the President's announcement. There is considerable debate by those participating in the *Apollo* program as to the best route for landing an American expedition on the moon. Should it be by direct ascent? By use of Earth and lunar rendezvous techniques? By means of a lunar "bug" which would ferry a team down to the lunar surface from an orbiting spacecraft?

Until the decision is made, much of the technical effort on the program cannot go ahead. Aerojet-General, for example, has a contract from North American Aviation to supply the propulsion engines for the service module of the *Apollo* spacecraft. Until it is determined whether that module actually will land on the moon or remain in orbit, work cannot begin on hardware. Already, there is talk that the 1967 target date cannot be met, that the slippage will be to 1968 or even later.

This does not mean all the time has been wasted. The mammoth task of setting up the management and procurement structure for the *Apollo* program is well along. Much of the technical work being carried out will be applicable no matter which route is chosen.

Perhaps it is wise to pause at this point to take a look at the technical problems involved before we are further committed. But the decision must be made as soon as possible. Once it is made, everyone in the program must support it whole-heartedly. This must include those who are now arguing heatedly on the opposite side. Without a unified effort, the program cannot move swiftly without faltering.

We are confident D. Brainerd Holmes will be as much of a dictator as necessary in enforcing the decision once it is made. That is as it should be. The effort is too widespread for any other approach.

The facilities and people of *Apollo* are spread throughout the nation:

One of the world's largest factories, standing barren and empty in a New Orleans swamp . . . huge test stands in the California desert . . . a snake-infested site on Mississippi's Pearl River . . . the bustling reception desk of a plant in the smog-covered industrial city of Downey, Calif. . . . the blackboard of an electronics engineer in Cedar Rapids, Iowa. . . .

There are the facilities of Project *Apollo*.

A scientist pondering guidance problems at the Massachusetts Institute of Technology . . . a technician operating a welding machine in Santa Monica, Calif. . . . top NASA and industry officials huddled over a table in a Washington briefing room . . . an Army officer studying architectural drawings in a Corps of Engineers office in Texas . . . a bargeman on the Tennessee River. . . .

These are the people of Project *Apollo*.

MISSILES AND ROCKETS is devoting almost this entire issue to a special report on *Apollo*.

To take a look at where Project *Apollo* now stands, to report on its organization and technical progress, to survey *Apollo* problems and to point the way for firms interested in sharing in this multibillion-dollar market, the MISSILES AND ROCKETS editorial staff spent weeks visiting the facilities and people of Project *Apollo*.

Our editors have been to the Manned Spacecraft Center at Houston, the Marshall Space Flight Center in Huntsville, NASA Headquarters in Washington, the Goddard Space Flight Center in Greenbelt, Md., to North American Aviation in California, Boeing in Washington State, Chrysler in Louisiana—and to many other firms and offices participating in the program.

They have talked to top officials on the *Apollo* program in both NASA and the industry, as well as to those on lower working levels.

The result, on the following pages, is the most comprehensive report to date on the fast-moving Manned Lunar Program. Without the fullest cooperation from the National Aeronautics and Space Administration and from the many firms in the program, this report would have been impossible. To NASA's D. Brainerd Holmes, Robert Gilruth and their fellow workers, to North American's Harrison Storms, Chrysler's James Smith and many others, our thanks.

FOR THOSE COMPANIES interested in participating in the *Apollo* program, we believe the report will be particularly useful. A special effort was made to talk to the procurement managers wherever we went. As a market guide to the procurement channels of the *Apollo* program, the following pages contain a great deal of information on "who is buying what where".

Capable, experienced suppliers are in great demand. There will be considerable contracting opportunities in the months ahead. We hope the report will be helpful in telling you where some of them are.

We hope it will be a useful guide to the technical and management areas of the program.

We hope it also will be useful as an outline of some of the critical problems facing both NASA and its industrial partners in the *Apollo* program.

William J. Coughlin

$6 Billion Payment in Next Two Years

First big installment on $20-30-billion lunar landing effort coming due; decision looms on choice of orbit

THE U.S. WILL POUR about $6 billion into Project *Apollo* over the next two fiscal years.

It will be the first massive down-payment on the Manned Lunar Landing Program, which it is estimated will cost $20 to $35 billion through the end of this decade.

Its objective will be to land three Americans on the moon—perhaps as early as 1967.

Many NASA officials, however, now feel that 1968 is a far more realistic date.

Besides funding a host of *Apollo* contracts already awarded to industry, the Fiscal '63 and '64 funds will provide a start on several new industrial awards.

One major decision—the detailing of the lunar mission and how it will be accomplished—is crucial at this point. On it hinges a real start on the lunar program.

While NASA officials are going on the assumption that Earth-orbital rendezvous will be chosen for the primary mission, a large group within the organization currently favors lunar-orbit rendezvous.

This would involve putting the *Apollo* spacecraft into orbit around the moon, and then sending a two-man capsule down to land on the lunar surface.

With this method, it would be possible to achieve the mission using one *Advanced Saturn* launch vehicle. This is opposed by NASA launch vehicle experts who feel that the mission would be "marginal."

The study is being made by the systems engineering group in NASA's Office of Manned Space Flight. Personnel from the Marshall Space Flight and Manned Spacecraft Center are also taking part.

A final decision by D. Brainerd Holmes, director of the *Apollo* program, is expected about July 1. A switch to a lunar orbit mission would drastically affect the lunar landing module for the spacecraft, and the command and service modules to a lesser extent.

The decision will also signal the real beginning of the Lunar Landing drive—with the resulting massive flow of funds to American industry.

Holmes told MISSILES AND ROCKETS that NASA's manned space flight activities are funded at $2.4 billion in Fiscal 1963.

Holmes said that the Office of Manned Space Flight would require $3.2 to $4 billion in Fiscal '64.

NASA officials report that the *Apollo* budget will continue to rise, reaching a plateau in fiscal 1965, '66 and '67 of between $4.5 and $5 billion. It will then drop slightly through the rest of the decade.

All of this means billions of dollars for U.S. industry. NASA estimates that about 90% of the funds over the next two fiscal years, some $5 billion, will go to industry for hardware procurement.

And while NASA has already selected contractors for some of Project *Apollo's* major systems, several more multimillion-dollar awards are yet to come. In addition, all of the lunar landing program's industrial team is just beginning the selection of thousands of subcontractors.

Future major contract awards include:

- **Inflatable or Erectable Manned Orbiting Space Laboratory**—Design of this spacecraft—which will hold at least 21 astronauts for periods of one to three years—will begin in Fiscal 1963. Actual hardware development could come in Fiscal '64. Total development time is estimated at four years.

The project does not have program status at NASA as yet. However, officials assert that it will definitely be the next major manned spacecraft developed by the civilian agency.



FIRST FULL-SCALE mock-up of North American's Apollo.

The Line-Up of Apollo Contractors

Company Name and Address	System	Announcement Date	Amount
Apollo Spacecraft			
North American Aviation, Inc. Space & Information Systems Div. 12214 Lakewood Blvd. Downey, Calif.	*Command & Service Modules*	*1961*	*$3 to 5 billion*
Subcontractors			
AiResearch Manufacturing Co. 6201 West Imperial Highway Los Angeles, Calif.	*Environmental control*	*12/21/61*	*$10 M*
Avco Corporation Wilmington, Mass.	*Heat shield*	*3/23/62*	*$8 M+*
Collins Radio Company 855 - 35th Street, N.E. Cedar Rapids, Iowa	*Telecommunications*	*12/21/61*	*$40 M+*

Robert R. Gilruth, director of the space agency's Manned Spacecraft Laboratory in Houston, Tex., told MISSILES AND ROCKETS, "I think it is a wonderful concept."

"It appears to be a very good configuration structurally, and is light for the amount of space it provides," Gilruth said.

No decision has yet been made whether the spacecraft will be of the inflatable or erectable type. NASA officials apparently are leaning toward a combination of both. Goodyear Rubber Co. has been doing a lot of work in the inflatable area and North American Aviation, Inc., is currently winding up a study of an erectable structure.

Besides serving as an orbiting laboratory for space experiments, it could become a space station for lunar, interplanetary and military manned missions in space. It could also be used for weather and astronomical observations.

• **Lunar Landing Module** — This will be awarded in two to six months. Although it was earlier scheduled to be awarded before the end of Fiscal '62, it has been delayed by further system studies of the *Apollo* mission. NASA's Lewis Research Center will manage the system under the overall supervision of the Manned Spacecraft Center.

NASA officials estimate its total funding at about one half of the total *Apollo* spacecraft cost of $3 to $5 billion.

• **Nova**—Total cost for this 12-to-20-million-lb.-thrust booster will be in the billions. Two fabrication contracts for the first and second stages will be awarded early in 1963. NASA is currently studying proposals from five missile/space firms—Martin Co., General Dynamics/Astronautics, North American Aviation, Inc., Douglas Aircraft Co. and Lockheed Aircraft Corp.—for a six-month design study contract. Two firms will be selected to make the study, and there is a good possibility these firms will eventually be named to build the stages.

• **Orbiting Laboratory module for Apollo spacecraft**—This module will be needed for the *Apollo* spacecraft only if weightlessness or radiation problems develop during NASA's 18-orbit *Mercury* and two-man Project *Gemini* flights. It would be capable of holding three astronauts. A modified *Apollo* command module is a possibility.

• **Advanced Saturn**—NASA is considering the selection of an "integration and test contractor" for the *Advanced Saturn*. A final decision, however, is about a year down the road.

• **RIFT**—The award of this contract is imminent. Three firms—Lockheed Aircraft Corp., Martin Co. and General Dynamics/Astronautics — are competing for the nuclear upper stage fabrication. The *RIFT* vehicle powered by the *Nerva* engine will be test-flown in the 1966-67 period and could be operational in 1968-69.

• **Flight plans**—While a final blueprint for the program hinges on the systems engineering study, NASA has set up some tentative flight schedules.

Beginning in early 1963, four 18-orbit or one-day missions will conclude Project *Mercury*. Beginning in 1963 and extending into 1965, two-man spacecraft flights of a week or more will be made with the *Gemini* spacecraft. A total of 15 missions are tentatively scheduled. Eight will involve rendezvous/docking operations while in orbit.

For Project *Apollo* itself, one NASA official estimated that a total of 25 flights will be scheduled.

These will begin in late 1964 or early 1965, when 12 development flights will be made, six utilizing a new solid rocket developed especially for the job and six *Saturn C-1* flights with boilerplate *Apollos*. Six manned Earth-orbital flights will follow using the *Saturn C-1*. In 1966 and early 1967, six manned circumlunar missions will be flown using a two-stage *Advanced Saturn*. The manned lunar landing mission would then be attempted.

To meet the flight schedule, NASA will spend from $12 to $20 billion on development of launch vehicles and from $3.5 to $10 billion on the *Apollo* spacecraft. Other billions will go for management and a large number of scientific satellites and spacecraft which will be needed.

• **Taking shape**—The general configuration of the *Apollo* mission systems is pretty well set.

The spacecraft will have three modules—command, service and lunar landing. Prime contract for the first two is North American Aviation.

The lunar landing contractor has not been selected.

Apollo will be the workhorse of the civilian space program well into the 1970's. Not until a manned interplanetary mission will a new spacecraft be needed.

Prime launch vehicles for the *Apollo* spacecraft are the *Saturn C-1* and *Advanced Saturn* boosters.

The *C-1* will be used to test boilerplate versions of the spacecraft and boost it on its Earth-orbital missions. First stage contractor is the Chrysler Corp. Second stage contractor is Douglas Aircraft Co.

The *Advanced Saturn* will launch the spacecraft on its lunar orbit missions and is now the prime launch vehicle for the lunar landing flight.

First stage contractor is the Boeing Co., and the second stage will be fabricated by North American Aviation Inc. Douglas has the third stage contract.

• **Procurement** — NASA contracting for the *Apollo* spacecraft is handled by the Manned Spacecraft Center in Houston, Tex. Launch vehicle procurement is directed by the Marshall Space Flight Center, with the Launch Opera-

(Continued on page 73)

Lockheed Propulsion Co. P.O. Box 111 Redlands, Calif.	Escape motor	2/13/62	$5 M
Marquardt Aircraft 16555 Saticoy Van Nuys, Calif.	Reaction control rocket engines	3/2/62	Undetermined
Aero-Minneapolis Div. Minneapolis-Honeywell 2600 Ridgeway Rd. Minneapolis 8, Minn.	Stabilization and flight control system	12/21/61	$30 M+
Pratt & Whitney Div. of United Aircraft East Hartford, Conn.	Fuel cell	3/9/62	
Ventura Div. Northrop Corp. 8000 Woodley Van Nuys, Calif.	Parachute landing system	12/21/61	$1 M+
Thiokol Chemical Corp. Hunter-Bristol Div. P.O. Box 27 Bristol, Pa.	Tower jettison motor	4/6/62	$1 M+
Aerojet-General Space Propulsion Div. Azusa, Calif.	Service module propulsion engine	5/3/62	$12 M

Guidance & Navigation System

MIT Instrumentation Lab. Cambridge 39, Mass.	Management of G&N	8/ /61	$20 million
AC Spark Plug Div. General Motors Corp. Milwaukee 1, Wis.	Inertial Platform & Assoc. GSE	5/8/62	$16 million
Raytheon Company Bedford, Mass.	Guidance Computer (on-board)	5/8/62	$2 million
Kollsman Instrument Co. Elmhurst, N.Y.	Optical Subsystems (G&N)	5/8/62	$2 million
Sperry Gyroscope Div. Sperry Rand Corp. Great Neck, L.I., N.Y.	Accelerometers (G&N System)	2/23/62	Est. $.8 million

No breakthroughs needed . . .

Technology Is Equal to Apollo Task

THE FANTASTICALLY COMPLEX job of landing American astronauts on the moon can be accomplished with existing U.S. know-how.

There are weighty engineering problems, and much hardware must be purchased to augment existing facilities, but no breakthroughs are required for constructing *Apollos* and launching them on the missions presently contemplated.

Guidance and control problems will be solved through today's technology. Both systems still must be built, tested and integrated. Final design now awaits a firm *Apollo* conceptual design.

Apollo's tracking, data acquistion, and telecommunications systems will be additions to, and modifications of, existing systems. Changes will be evolutionary—developing with changing requirements, from the 18-orbit *Mercury* missions through the *Apollo* lunar landing.

The crucial thermal protection system for the *Apollo* spacecraft's return to Earth likewise relies on current state of the art. No technological problems are anticipated in the protection mechanism, although some engineering innovations may become necessary as the lunar program moves closer to fruition.

Radiation hazards and the problems of weightlessness still demand considerable study. Space medicine problems, however, are being tackled by a massive task force from NASA, the Air Force, Navy and Atomic Energy Commission. Allowing for all the present unknowns, experts believe that the *Apollo* missions are well within the present state of the art.

The following is an examination of technical problems in major categories.

GUIDANCE & CONTROL

RESPONSIBILITY for the NASA's advanced R&D efforts for *Apollo* in electronics, guidance, and control rests with the office of Cmdr. Albert J. Kelley. The basic system, according to Kelley—Director of Electronics and Control in the Office of Advanced Research and Technology—will be developed and standardized around the guidance package used in the initial Earth-orbiting mission.

As mission complexity warrants, the G&C system will be supplemented by additional modules, not by performing a major system overhaul.

MIT, Minneapolis-Honeywell and AC Spark are at present the principal contractors for *Apollo* guidance and control.

Selected last year as associate prime contractor for the design and development of the *Apollo* guidance system, MIT's Instrumentation Laboratory will be responsible for the Earth-orbiting guidance and navigation packages and also for the complete system required for circumlunar and lunar-landing missions.

MIT's present contract is just over $4.3 million. Over the next six to seven years, its total funding probably will exceed $30 million, observers say.

Three companies were selected in early May for production of major components of the MIT guidance and navigation system: AC Spark Plug Division of General Motors Corp., Raytheon Company, and Kollsman Instrument Corp.

AC Spark ($16 million) will build the MIT inertial guidance platform, and associated electronics, ground and on-board checkout systems, and other related GSE.

Raytheon ($2 million) will build the on-board digital G&N computer and Kollsman ($2 million) will build the optical subsystems. The latter include a space sextant, sun seekers, and navigation display equipment.

Following MIT's fabrication of the initial guidance system, the three contractors will contribute to the production of the follow-on systems which will be integrated with other *Apollo* flight systems by North American Aviation's Space and Information Systems Division (SISD).

Honeywell is a subcontractor to S& ISD for design and development of the stabilization and flight control system. SISD is associate prime to NASA for the development and systems integration of the *Apollo* launch escape structure, command capsule, service module, and lunar landing module. Reportedly, the division has increased Honeywell's role considerably in the interest of maintaining dynamic integrity of the complete flight system. Thus, M-H has closed-loop responsibility for all systems associated with flight control.

Although the initial M-H contract was announced as $30 million. this value is already believed to have been trebled and will ultimately approach several hundred million dollars through 1970.

• **MIT's approach** — The "zero-miss" *Apollo* guidance system described to MISSILES & ROCKETS by Dr. C. Stark Draper, director of MIT's Instrumentation Lab, avoids any of the short, pat descriptions generally given to most guidance networks.

The system currently being studied is a totally integrated one. It will supply guidance and navigation data for the spacecraft throughout all phases of the lunar flight; it involves a very complex set of inter-relationships with the vehicle, communications system, mission profile, and crew control.

Basic portion of the guidance system is inertial. Optical, radio, and radar links are also included for use as prime navigational systems at certain stages of the flight and for refinement of guidance information at other times.

Though designed to operate automatically, the crew retains the option to override the system.

Dr. Draper says that the inertial element alone will be entirely adequate for terrestrial launch and land operations and also for short range rendezvous. The re-entry operation will depend on adequate mid-course information fed to the inertial measurement unit by other devices within the overall system. The celestial navigation and RF links will be used almost exclusively during the mid-course phase.

There will be times during the mid-

course when the inertial portion of the system could be used as an aid to vehicle attitude control, as a method for carrying out certain course maneuvers, and as a short term inertial reference to aid in obtaining celestial sightings.

Though few actual details are available on *Apollo* guidance system design, Dr. Draper indicated that the system would not be too dissimilar from general criteria for space navigation gyroscopes he has previously outlined.

Expected to be at the heart of the inertial measuring unit are three single-degree-of-freedom floated integrated gyros, a design which Dr. Draper has successfully employed on *Polaris* and which has also been used on *Titan* and *Thor* guidance systems. The gyros employ magnetic suspension devices which, according to Draper, reduce torque disturbances and give complete immunity to shock and vibration effects.

The three gyros will be mounted on the inner gimbal member (stable platform) of the three gimbal system. Three accelerometers will also be mounted on the inner gimbal member. The types used are expected to be pendulus integrating gyro accelerometers.

In order to achieve the accuracies and reliabilities required in the *Apollo* mission, the Instrumentation Lab is concentrating on development of low-power gyroscopic components and inertial measuring units, with corresponding benefits in power supply and thermal system demands. Also, project engineers speculate that lower temperature operation resulting from lower power needs will contribute to overall operating life, reliability, and component calibration.

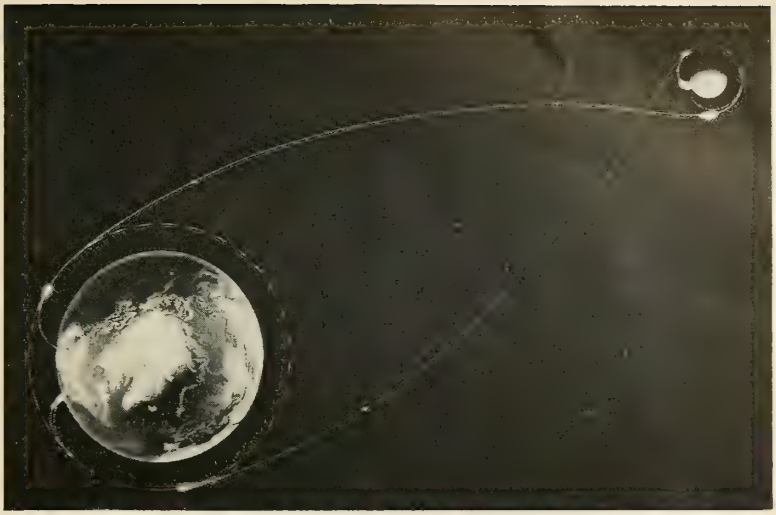
Weight of the *Apollo* guidance system, exclusive of the guidance computer, reportedly will be well below 100 lbs. About 75% of the weight is concentrated in the mechanical assembly. The remainder is for electronics to drive the gimbal servos, regulate power, generate ac to drive inertial component rotors, and operate the timing device.

Total power requirement for the fully active inertial measurement unit is expected to be below 200 watts. About 2/3 of this will be dissipated in the electronic package, and the remainder throughout the mechanical assembly.

Power for the launch vehicle guidance will probably be supplied by rechargable battery units.

Dr. Draper also indicates that current design calls for primarily digital computer elements in the guidance system, with some tight-loop analog sections included. He reports that crew display of guidance and navigation data will be achieved with cathode-ray-tube techniques.

According to Dr. Draper, the overall design of *Apollo* guidance is advanced primarily in the sense that it takes full advantage of the current state-of-the-art in component and systems. He does not look at inertial, celestial, and R-F techniques embodied in one system as solely a matter of redundancy



NASA ARTIST'S concept shows complexity of guidance for lunar landing mission.

If one portion of the guidance system can be said to be pushing the state-of-the-art it is probably the space sextant to be carried aboard *Apollo*. This high precision device will use optical wavelengths for LOS measurements between the spacecraft and various celestial bodies. The sextant can operate either manually or automatically.

In terms of performance demands of gyroscopic systems, Draper feels the requirement for ballistic missile systems are more demanding than those for space application. "The requirements for attitude control, mid-course maneuvers, spacecraft launch guidance, and re-entry guidance all require equal or less performance than for the ballistic missile," he asserts.

• **M-H's tasks**—Under the direction of North American, Honeywell has almost total responsibility for the entire flight regime. Part of its task includes a study of interface implications of integrating the guidance and navigation system with the stabilization and control systems.

Honeywell has design, developmental and provisioning responsibility for:

—Manual controls (translation, rotation, thrust)

—Attitude sensing (attitude and rate gyros)

—Flight control converters

—Flight control computers

—Electronic control assembly

—Checkout system (bench and launch GSE and on-board checkout)

—Thrust vector control (escape rocket)

—Display panel (command module)

—Total integration of displays and human dynamics

In addition, the company will perform human factors engineering for flight management. This task will include astronaut training, redundancy reduction by standardizing module replacement and on board maintenance, and determination of inter-human resolution during flight.

In all, 36 different studies are now being performed by Honeywell. The first breadboard flight control system is undergoing test simulations now.

The biggest problem faced by both MIT and M-H is that of keeping hardware development moving while keeping designs flexible enough to cope with continual conceptual changes. ⌗

TRACKING—DATA ACQUISITION

THE BASIC *Mercury* net will be the nucleus of the future Manned Flight Tracking Network, according to officials at NASA Headquarters in Washington. This evolution by augmentation is now in process, growing by requirement-phase from the 18-orbit (1-day) *Mercury* mission, through *Gemini* to *Apollo* and on.

Fiscal '62 funding to support the 1-day orbital mission is $11.9 million. FY '63 funding for *Gemini* tracking and data acquisition requirements is $35.95 million. This figure includes some *Apollo* long lead-time items.

Goddard Space Flight Center has responsibility for the network through the 1-day orbital mission. NASA Headquarters is in the process of finalizing requirements for the *Gemini* program. As the detailed requirements are firmed up, Goddard's task will grow.

The present 18-station *Mercury* net will require no additional ground stations or any relocation of ground stations, as the future system is currently envisioned. However, possibly five tracking ships, in addition to the existing two telemetry ships, will be needed.

Location of a Manned-Mission Control Center probably will be at Houston.

Since network growth is related directly to mission phase requirements (and, of course, booster or launch capabilities) here is how the augmentation may develop. It is emphasized that only the NASA requirements for the 1-day orbital mission are firm.

• **One-day orbital needs** — Additional command facilities at selected recovery-area stations will be needed. Also, slight telemetry augmentation at some stations will be needed to meet present IRIG capability for greater data transmission.

The Bermuda station will be remoted to the command center at Canaveral by cable. This will be accomplished hopefully before but at least in time for this mission.

A voice communications capability (ground-to-ground) will be added for all ground stations.

Also, a similar voice capability will be added to each of the two telemetry vessels. These ships will be relocated: the present Atlantic ship will be given command capability and will be placed in the Pacific off the coast of Chile; the Indian Ocean vessel will be moved to a point off the east coast of Madagascar.

All these requirements are now in the process of being fulfilled, according to G. M. Truszynski, Deputy Director of Tracking & Data Acquisition at NASA Headquarters.

• **Gemini requirements** — Detailed T&DA requirements for this mission are now being definitized by experts from NASA's Headquarters, Goddard and Houston.

NASA feels it probably will require two more range ships for tracking and telemetry: one for coverage in the *Gemini* injection/abort area beyond Bermuda, the other for retro-maneuver coverage in the area west of Hawaii.

A need may exist for the addition of a digital command capability at selected sites for *Agena* control. This augmentation would be needed only at those critical sites at points in the vehicle trajectory where maneuvers will be initiated.

Terminal instrumentation for ranging and positioning will be needed in selected recovery areas.

Other changes include increased range indication for some radars from the present 500-mile readout to 5000 miles range, added PCM telemetry at some ground stations (to flight qualify PCM for *Apollo*), and on-site automatic readout (data transmission) capability from some tracking stations to the control center via teleprinter.

• **Orbital Apollo** — It is expected that PCM telemetry will be required at all stations for *Apollo* missions to achieve higher telemetering efficiency and to handle the vastly increased data load.

All stations not equipped at this time with FM/FM telemetry will have receiving equipment installed.

S-band radars will be installed at a few sites for equipment checkout prior to its use during the later lunar missions. The intent also will be to assure system compatibility with the Deep Space Instrumentation Facility (DSIF).

Two additional tracking vessels may be needed of this mission—one in the Atlantic and one for the Pacific.

A mission control center, possibly at Houston, may be constructed at this time for later lunar *Apollo* missions. The center may also be given a computational capability, but in any event, added communications circuits would be necessary between it and Goddard and the Cape—probably four voice-quality land lines.

• **Lunar missions** — For the comparatively long range lunar trips, the DSIF will come into use. This is still far in the future and changes to the existing system largely will be to maintain compatibility with equipment in the space vehicle.

It is expected that masers will be installed at all stations to reduce received noise level.

Antennas will be converted from prime-focus-feed to Cassegrain-feed for greater overall system sensitivity.

Among the many other expected DSIF augmentations are multi-channel receivers to permit multi-mission control, precision time standards, angle encoding equipment, and star tracking and pointing subsystems.

All three stations will have radio command capability as will those of the Manned Mission Tracking Net. Some of the latter stations may also have the co-location of duplicate facilities for redundancy and increased load capacity.

There is still doubt as to whether or not the existing 85-ft. dia. main tracking dishes in the DSIF will be replaced or supplemented by new 210-ft. dishes. At the present time, they do not appear necessary for *Apollo*.

For the lunar landing and return mission, a fifth tracking ship may be needed in the Pacific area. This would make a total of three located southwest of Hawaii.

Also, alternate landing sites and augmentation of the then existing recovery-site instrumentation may be needed to further extend the energy management capability. ⌗

RE-ENTRY

A MULTIPLE-DEFENSE mechanism based on plastic-reinforced, charring ablation materials may well be the route taken by Avco Corp.'s Research and Advanced Development Division in its design and construction of the crucial *Apollo* re-entry shields.

Avco will build the heat shield under subcontract to North American Aviation. While no definitive contract has yet been drawn—making it impossible to state the length and total value involved—the initial award is expected to exceed $8 million.

The nature of the work involves designing and building the thermal protection system for parabolic re-entry. It includes the research necessary to establish the re-entry heating conditions and design, develop and manufacture materials dictated by these conditions. Then comes the actual fabrication and installation.

Avco spokesmen feel this project can be handled with only the normal development efforts associated with a program of this scope. No fundamental breakthroughs will be necessary.

The charring materials are in existence and offer a state-of-the-art solution within the boundaries of realistic design weights. They are well within the nature of the heating rates and time duration.

Re-entry research has been going on for a long time at AvcoRAD. The multiple-defense approach simply means using every bit of material in a thermal protection shield to dissipate heat energy.

Combinations of mechanisms in composite charring structures have been under active investigation for some time. Complete description of the results, together with evolved explanations, was presented by an AvcoRAD research team earlier this year at a technical symposium devoted to plastics.

A great deal of work has gone into exploring epoxies—and the effort has been successful. Understanding the degradation of these plastics in the simulated and actual conditions of re-entry has given the firm a substantial technical base. Phenolics have dominated the plastics work in this area across the U.S., but Avco switched into epoxies early in the game.

• **Ceramics first**—The initial ablative materials developed to withstand re-entry consisted of a metal-reinforced silica composition which had excellent ablative properties but possessed too much thermal conductivity and too little mechanical strength for most applications. A second class of materials designed to overcome these difficulties

were composites containing 60 to 85% by weight of silica in combination with thermosetting resins. These materials significantly improved the shortcomings found in the ceramic systems.

AvcoRAD initiated a charring polymers program in an effort to further improve properties. The work was supported by the Ballistic Missile Division of the U.S. Air Force. These materials generally have high heats of ablation and are relatively easy to manufacture, says A. C. Walker Jr., chief, Polymers & Plastics Section. In addition, they can be tailored for low density, low thermal conductivity and good mechanical properties.

Charring plastics possess the most important advantages of pyrolytic graphite in many ways—high surface temperature and low conductivity normal to the surface, for example. The economic penalties—difficulties in fabrication, or fragility associated with pyrolytic graphite—are avoided. The low "effective" conductivity of the char layer results from the porous structure of the char itself, from the effect of the endothermic decomposition of gases which flow through the pores, and from the thickening and cooling effect of the decomposition products on the boundary layer. In a nutshell—multiple thermal protection.

• **Char mechanism**—When a polymer is pyrolyzed, two reactions are in competition. One is elimination of groups along the chain which leave the carbon skeleton intact, and the other is chain cleavage to lower molecular weight products.

If elimination predominates over cleavage, most of the original chain structure will remain as carbon and a char will develop. If the reverse is true, the process will become essentially one of distillation, and typical cold-wall ablation will result.

Systems which possess stronger *C-X* than *C-C* bonds, and which are incapable of eliminating low-energy compounds, will be reduced exclusively to low-molecular-weight volatiles during pyrolysis because the chain-cleavage reaction predominates. This behavior is also subject to modification by residual catalyst, terminal unsaturation or other chain imperfections—as are charring polymers.

One of the factors which appears to contribute to char formation is a high cross-link density. It is likely, says Walker, that thermosetting resins as a class will be more susceptible to char formation than their linear cousins.

In an attempt to gain a better understanding of the nature and structure of the ablative chars, microscopic examinations and X-ray diffraction studies were carried out in char layers. These studies revealed that pyrolytic graphite as well as polymer degradation residue is present in ablative char layers. These findings, plus observations and data obtained in other phases of the ablation work, guided initial development of potentially improved, controllable ablative materials.

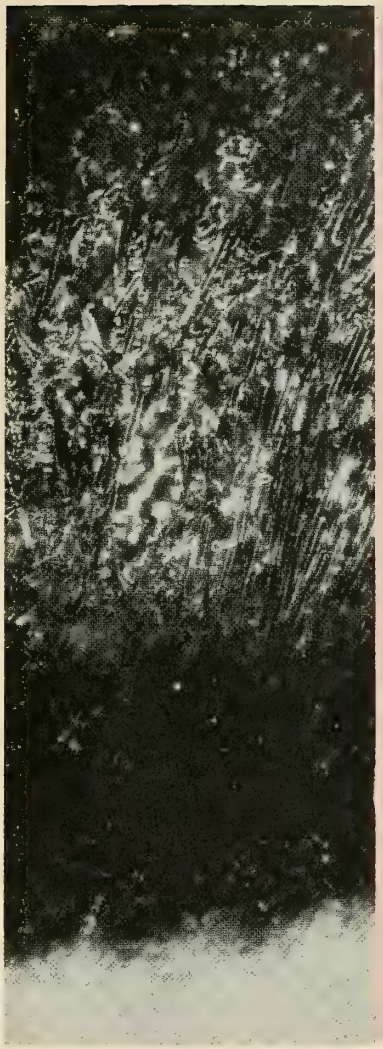


PHOTO AND CHART illustrate process of pyrolytic graphite formation.

• **Pyrolytic graphite formation**—When a charring polymer is exposed to a high-heat flux, high-enthalpy heat source, it produces carbonaceous char and gaseous products. If the carbonaceous char is able to resist complete mechanical and chemical erosion, it becomes hot and acts as a substrate for the deposition of pyrolytic graphite from the gaseous fraction of the polymer degradation products.

This results in a char layer which is not uniform, but consists of discrete zones which attenuate the incident thermal energy. The interface between the char and the base resin is composed of pyrolizing carbonaceous material and rapidly effusing low-molecular-weight vapors. This lowest portion of the char is called the "carbonaceous zone."

When the temperature in the direction of the sample surface reaches about 1000°C, graphite is deposited on the hot carbonaceous residue from the effusing organic vapor. This zone is referred to as the "prolytic graphite deposition zone." An increase in temperature continues as the front face of the char is approached. Near the surface, a decrease in char strength and density takes place and results in mechanical and oxidative erosion.

Catalysts, especially Lewis acids, have been used to induce ablative chars in otherwise noncharring resin systems. It appears possible that residual carbolic acid in the cured novolac epoxy system may contribute to char formation. Preliminary experiments appear to bear out this theory.

(Continued on page 62)



New Avenues in Space Technology

. . . at AVCO/RAD

Increased activity on such long-range projects as APOLLO, TITAN, ATLAS, MINUTEMAN, & NIKE-ZEUS plus a multitude of advanced space-oriented programs have created broad vistas of professional advancement for qualified engineers and scientists at Avco/RAD.

Within this wide spectrum of challenging activity are assignments which embrace all the basic scientific and engineering disciplines and their inter-relationships.

This magnitude of creative opportunity is evidenced by Avco/RAD's responsibility for the vital APOLLO heat shield, its work on the structure and interstage of the Air Force Satellite Inspector Vehicle; the construction of target decoy vehicles for NIKE-ZEUS and numerous other contracts. Promising work is also being carried on in super-size rocket nozzles, proprietary materials and thermionic and thermoelectric energy conversion.

Openings exist for Sr. Scientists & Engineers in the following areas:

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- **Aerodynamics**
- **Mathematics**
- **Guidance & Control**
- **Ground Test & Evaluation**
- **Aerospace Vehicle Design**



To support these activities the Division's 23 million dollar facilities, located just north of metropolitan Boston, has recently added a new space research laboratory to simulate conditions encountered by vehicles returning to earth after lunar and interplanetary missions.

Send resume to
Mr. J. Bergin, Dept. OAB

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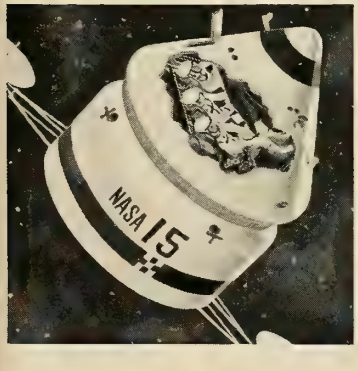
JOIN JOHNSON, KOPECKY & ERICKSON

ON THE HONEYWELL APOLLO TEAM



These three engineers are experiencing the satisfaction of working on one of the most interesting projects of our time—the manned trip to the moon and back. Vern Johnson (left), formerly of Cleveland, feels his job offers tremendous opportunities because "what I am doing today will be directly related to any new space travel and space vehicle control."

John Kopecky (center), recently from the Los Angeles Area, enjoys working on Apollo because "the work is so new . . . Many of the things we are doing have never been done before!" Bud Erickson (right), an instrumentation designer, is most enthusiastic about his group's "success in the increased reliability standards for space vehicle instrumentation."



The three-man Apollo spacecraft

will use Honeywell designed and developed stabilization, control and display systems. The Apollo program, to be completed by 1970, will cover four phases: Orbit of the earth; circumnavigation of the moon; orbit of the moon and return; and landing on the moon and return. Honeywell has stabilization and control systems in use or slated for use on the X-15, Mercury and Gemini in addition to Apollo.

Honeywell

H HONEYWELL *Military Products Group*

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INSTRUMENTATION AND DISPLAYS ENGINEER

BACKGROUND: BSEE or BSME with Electro-Servomechanisms experience. Should have extensive knowledge in field of electro-mechanical instrumentation systems specification and design of display hardware for aircraft. Should also be experienced in analyses of pilot requirements and limitations influencing display hardware. Must be familiar with digital and analog servo systems. Will be assigned to the design and development of hardware for cockpit displays on the Apollo space Vehicle.

CIRCUIT ENGINEER

BACKGROUND: BSEE—must have extensive experience in low power instrumentation and display electronics analysis and design. Competence in transistor electronics for aircraft systems is required. Knowledge in computer display interface circuitry is desirable. To be assigned responsibilities in areas of system analysis and electronic equipment design for Aerospace Vehicle.

PACKAGING ENGINEER

BACKGROUND: BSME with several years experience in aircraft electronic packaging techniques is required. Must be familiar with analog, digital and low-powered servo systems combined with logic block circuitry packaging techniques. To do design and development packaging for Aerospace Vehicles. Will be responsible for hardware packaging of miniaturized airborne computer interface electronics, and display hardware.

MICROELECTRONICS ENGINEER

BACKGROUND: BSEE or BSME with graduate school work in physics. Some experience in transistor circuit design is required with current experience in microcircuitry fabrication and processing. Will analyze, develop and design packaging for microcircuitry to meet various needs of reiterative building blocks or custom electronic function requirements.

Qualified applicants send resume to: Mr. Roy Richardson, Director of Technical Service, Minneapolis-Honeywell Aeronautical Division, 2652 Ridgway Road, Minneapolis 40, Minn.

To explore professional opportunities in other Honeywell locations, coast to coast, send your application in confidence to Mr. H. T. Eckstrom, Minneapolis-Honeywell, Minneapolis 8, Minn.

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CELESTIAL NAVIGATION Space vehicles will hasten their own evolution as information gained from each orbiting study spurs the creative imagination of design engineers. Anticipating rapid advances in satellite range and controllability, Kollsman is pacing its refinement of astro tracking systems accordingly. At the same time, it is making significant progress in horizon scanners and sun sensors. □ Since 1946, Kollsman has been both the research and production leader in space-age celestial navigation systems. Aggregate output: more than 10 times that of all other free world producers combined. No other source has equal ability to meet specific requirements, whether for manned aircraft, missiles or space vehicles.

Aerospace Ground Equipment
Aerospace Instruments
Celestial Navigation
Display Systems
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Ordnance
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Kollsman Instrument Corporation

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CAMERON
MISSILE
FORGINGS

THE MOST FROM MOLYBDENUM

Jet engines, rockets and missiles require the most refractory materials available—special shapes, thin sections, strength at high temperature and stability in the presence of blasting flame. Cameron is proud of its part in the advanced techniques of the space age.

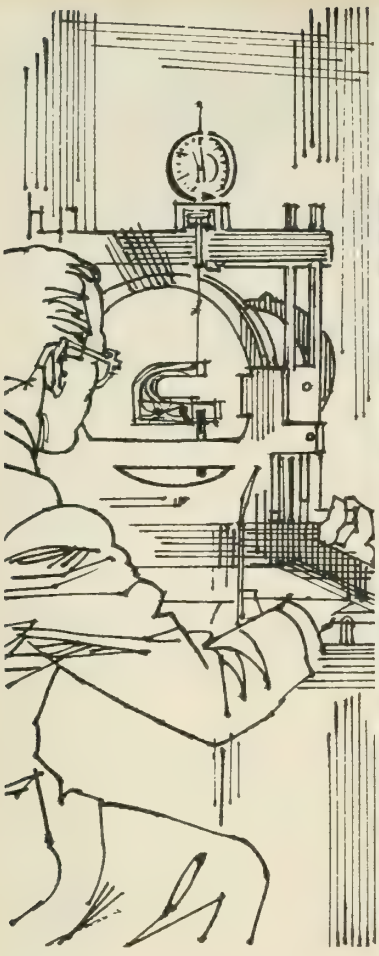
Consider the special Molybdenum forgings pictured. At 2500°F and above, Molybdenum has the properties desired—high strength, ductility and stability in the presence of intense flame. Thin, complicated parts were needed but cast or conventionally forged molybdenum at ordinary temperatures evidenced brittleness making handling and machining a major problem. Also, Molybdenum is costly, so conservation of material was essential.

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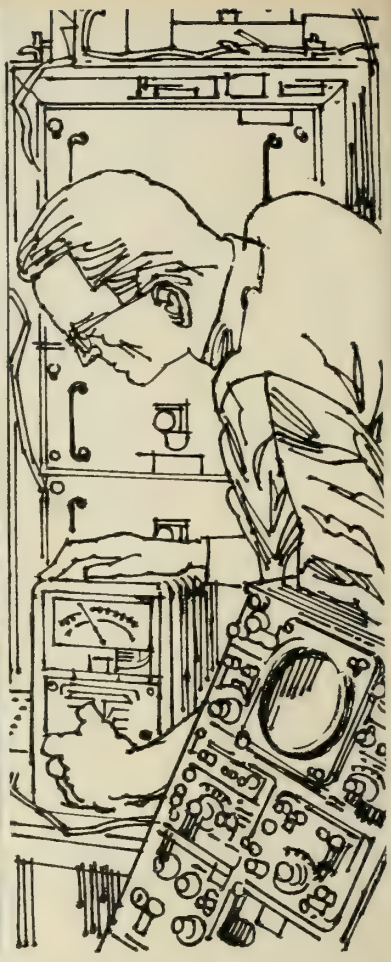
If you have design problems involving high stresses, high temperatures or large intricately shaped metal parts, check with Cameron.

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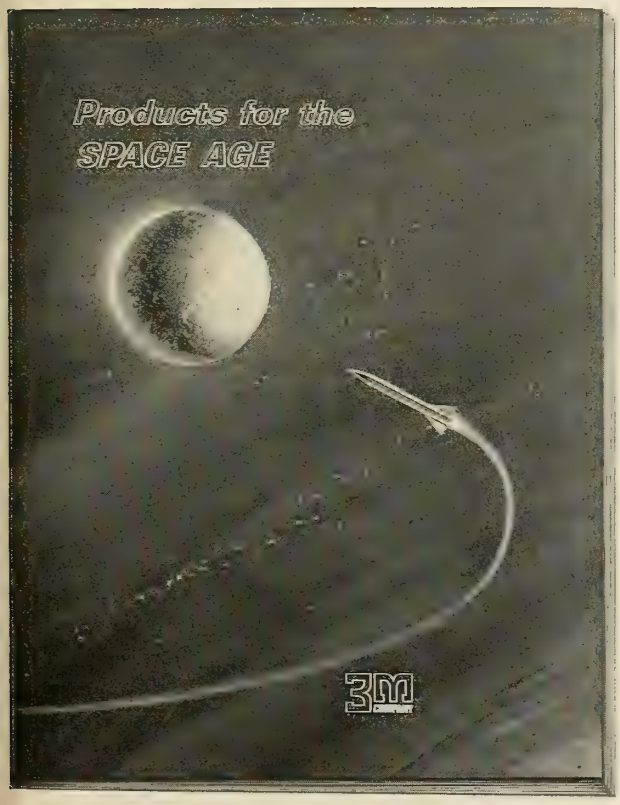
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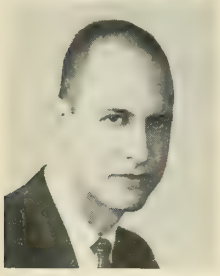
Office grows rapidly . . .

NASA HQ Builds Management Complex

While temporarily contracting with AT&T and GE for assistance, agency plans to run entire show on its own



D. Brainerd Holmes
Makes moon program decisions.



George M. Low
Directs spacecraft group.



Milton W. Rosen
Heads launch vehicles office.

THE NATIONAL Aeronautics and Space Administration is attempting the biggest management job in history solely with government personnel.

In a sharp departure from earlier large space and missile programs, the civilian agency is rapidly building a huge management complex aimed at handling every detail of the manned lunar landing program.

There is to be complete avoidance of outside dependence on the high-caliber systems management formerly supplied to the military by such organizations as Aerospace Corp. and Mitre.

Although some industrial firms are under contract to supply brainpower, NASA officials look on this as an interim stop-gap designed to permit systems functioning at the start while in-house capabilities are strengthened.

Officials also stress that none of the firms have any management responsibility. This, they declare, remains in the hands of the space agency.

Assisting in the vast management complex is NASA's total complement of 24,000. Major responsibility for the program's financial, contracting and technical management, however, is held by NASA headquarters in Washington and its Office of Manned Spaceflight.

The office which was set up during the gigantic NASA reorganization last November is growing rapidly. Its total complement at the end of June will be an estimated 250; by December, 1962, it will approach 500—and a total force of at least 600 is expected as the manned lunar landing program moves into high gear.

• **Holmes decides** — Directing the office is D. Brainerd Holmes, the closest thing to an American Moon Czar.

While he reports to Associate Administrator Dr. Robert C. Seamans, Jr., the basic decisions are made by Holmes.

This is aptly illustrated in the setup of the Manned Space Flight Management Council, the chief tool used by Holmes to run the program.

It is composed of Holmes; his assistant directors; Dr. Wernher von Braun, director of NASA's Marshall Space Flight Center; Robert H. Gilruth, director of Manned Spacecraft Center; Kurt Debus, director of the Launch Operations Center at Cape Canaveral; and their assistant directors.

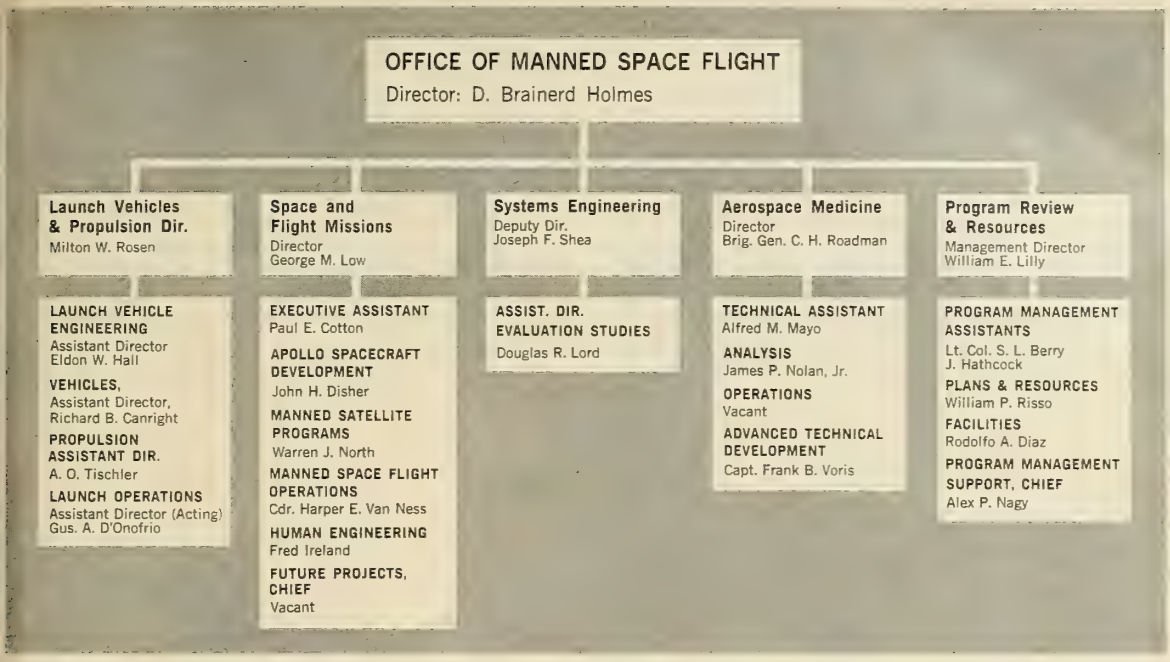
Meetings are held once a month to discuss problems in the manned lunar program.

It is not a democratic group. While the other members of the council can discuss the various issues and make recommendations, "I make the decision," declares Holmes.

• **Outside help**—The second major change inaugurated by Holmes has been the attempt to set up an in-house systems engineering and integration group with the aid of two industrial contractors—American Telephone and Telegraph Co. and General Electric Co.

Under Deputy Director for Systems Engineering Dr. Joseph F. Shea, a small but growing group is developing systems competence in the overall planning for mission definition, reliability, design, human factors, communications and control. The group handles system studies, engineering and analysis.

With a present complement of 45, the group is too small to adequately



perform its assigned task without additional help. The current mode of operation is to call on the systems capability within the centers and also outside contractors to make systems men available under contract.

In this case, American Telephone and Telegraph is under contract to supply a group of systems-oriented people on a full-time basis to the Systems Engineering group at NASA. This contractor group, known as BellCom, provides support capability in evaluation and monitoring functions to NASA—but only in the sense of developing the factual basis for NASA decisions.

BellCom will have no direct authority. It does not manage.

Over 20 specialists are already at work within BellCom, and it is anticipated that the team will reach 200 within a year—at a cost to NASA of several million dollars.

• **Integration/Checkout** — A similar management tool is being used by the Integration and Checkout group in the Manned Space Flight Office. Under James E. Sloan, the aim is the same—to build in-house capability in the vast task of managing systems integration, checkout and reliability assessment.

One job of Sloan's group is to see that all checkout equipment falls under a common design philosophy. Again, a lack of personnel is corrected by bringin an outside contractor, in much the same manner as does Systems Engineering.

In this case, General Electric is under contract to supply specialists, primarily in the area of check-out but other functions will be handled by the group. Once again, the decision and management capability will remain with NASA.

In both cases, the method used to augment the building of a NASA in-house management force carries a problem in government-industry relations. A situation exists where two industrial contractors will have payroll men privy to the highest planning levels in the manned space flight program. Just how effective NASA will be in isolating these groups from their own companies remains to be seen.

In reality this may be a ghost problem. But the space agency is well aware of the pitfalls here, and the arrangements covering the situation will probably satisfy even the most cynical.

• **Other groups**—Besides the systems offices, four other groups assist Holmes in running the program.

These are the offices of Launch Vehicles and Propulsion, Spacecraft and Flight Missions. Aerospace Medicine, and Program Review and Resources Management.

In charge of the launch vehicles office is Milton W. Rosen. George M. Low directs the spacecraft group.

Under Holmes' management concept, the two men serve a dual role.

Holmes considers Lowe his representative at the Manned Spacecraft Center in Houston. At the same time, he serves as Gilruth's representative at NASA headquarters.

The same relationship exists between Rosen and the Office of Manned Space Flight and the Marshall Space Flight Center.

In addition to responsibility for managing *Apollo* spacecraft development, Low's main duties are to plan all manned space flight mission operations, the integration of spacecraft systems, and the ground support operations facilities.

He has four assistant directors. The assistant director for Manned Satellite Programs directs the *Mercury* and *Gemini* programs at Headquarters. The other assistants deal with Spacecraft Development, Manned Spaceflight Operations, and Human Factors Engineering.

Rosen's office directs management of the *Saturn, Advanced Saturn* and *Nova* boosters. His four assistant directors handle vehicle development and fabrication of facilities, propulsion—including development of rocket engines for manned spaceflight, launch operations and launch vehicle engineering.

The Programs Review office headed by William E. Lilly advises Holmes on budgetary aspects of the *Apollo* program.

Technical direction of space medicine problems is directed by the Aerospace Medicine Office, headed by Brig. Gen. Charles H. Roadman. His office also provides liaison with DOD and other scientific and technical groups and plans the department's budget.

Next to Roadman is deputy director Col. George Knauf. Three assistant directors, for development, test and evaluation; operations; and plans and programs—divide up the functional areas of the Office of Aerospace Medicine. ⌘

With office at Downey . . .

Houston Oversees Spacecraft Work

Interested suppliers told to contact Project Office with 'breakthrough' ideas —otherwise write NAA

NASA's management responsibility for the *Apollo* spacecraft itself rests with the Apollo Spacecraft Project Office in the embryonic Manned Spacecraft Center at Houston, Tex.

MSC presently is scattered in six buildings in Houston while waiting for construction to start on its $90-million facility at nearby Clear Lake. Site preparation there is under way, with first occupancy expected in about 18 months. The Army Corps of Engineers expects to call for bids on the job in August, with construction to start in September.

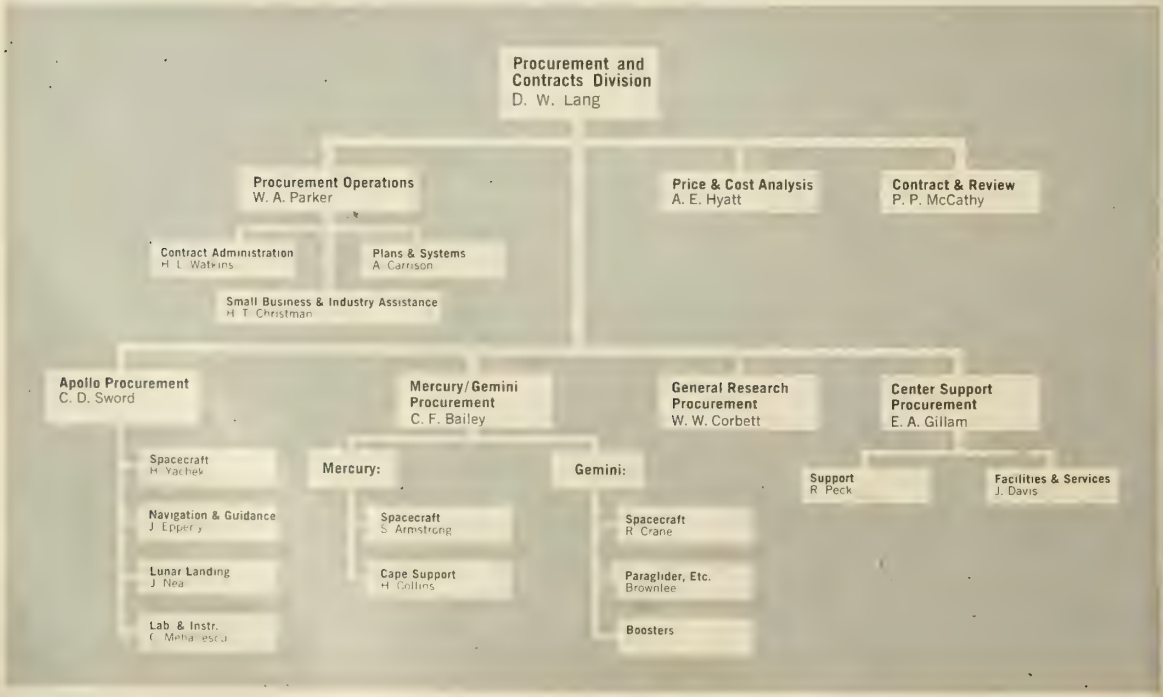
MSC's Apollo Project Office oversees fabrication of the spacecraft by North American Aviation and other contractors in the program. The office, under project manager Charles Frick, must assure that the spacecraft is on schedule, within cost, and meets requirements.

Its assignment covers systems integration; command, service and lunar landing modules; guidance and control; and planning and resources.

The office is one of three project offices in the center (others are the *Mercury* and *Gemini*). To carry out its duties, the *Apollo* group draws heavily on the supporting arms of the center—particularly, at this stage, on the assistant directorate for research and development. The R&D organization provides the "muscle" for the project office.

• **Four groups** — These divisions within the R&D directorate support the *Apollo* assignment:

—*Spacecraft Research Division.* This is primarily an analytical systems engineering effort devoting much of its attention to interface effects. The Spacecraft Integration Branch studies the overall spacecraft design and the marry-







STEAM SHOVEL at left breaks ground for $90-million Clear Lake facility depicted in architect's drawing at right.

ing of systems—how, for example, to design a lunar excursion vehicle if that route is chosen. The Flight Vehicles Integration Branch goes beyond study of the spacecraft to consider all aspects of propulsion in the program.

Other branches of this division deal with structures, heating and flight dynamics. The latter group carries out analytical work on flight trajectories, wind tunnel studies, and analog computations. The wind tunnel effort is expected to remain an important phase of the project for another year.

—*Systems Evaluation and Development Division.* This is a hardware-oriented group. Its major *Apollo* work is concerned with electronics, communications and instrumentation, providing the project office with an analytical and review capability of the work carried out by contractors.

NASA itself will provide the R&D instrumentation for the early *Apollo* test flights. It is being designated by this group and components will be procured by the Houston center.

Another branch within the division is concerned with the landing system, power supply, thermal control of the spacecraft environment, and attitude control.

—*Life Systems Division.* This organization is still attempting to establish design criteria for crew tolerances in the *Apollo* missions — what loads the crew can withstand, for example, or what environments are endurable for extended periods.

Government-furnished equipment for the mission will include spacesuits. This group will be contract manager for the suits. Another GFE item which will be procured from this office will be the back-pack life support system for lunar exploration.

The division also is carrying out an R&D effort on other personnel gear such as life rafts, rescue aids and parachutes. Personnel parachutes for *Apollo* are now under study.

—*Space Physics Division.* This organization, still in its formative stage, will have two functions. First will be application of environmental criteria to spacecraft design — micrometeorites, hard radiation, lunar and planetary surfaces. MSC, it is felt, must participate in general space science at the proper level to know what must be applied to the design of spacecraft. This, in effect, is an interface with the scientific community.

The other function of the space physics group will be to oversee selection of scientific experiments going aboard manned spacecraft.

• **Contract relations**—How do the project office and the R&D directorate work with contractors and subcontractors on the program? To maintain day-to-day supervision of the work at North American Aviation, a NASA office is established at NAA's Downey plant.

NAA is expected to keep Houston informed of the activities of subcontractors. To maintain the proper relationship between NAA and its subcontractors, the Houston office approaches subcontractors only with the "approval" of, and after consultation with, North American.

"We have an understanding that we can always go to the sub but that we always will go with NAA," says a spokesman.

In dealings with contractors and subcontractors, the R&D directorate serves as a consultant to the project office. The system is streamlined to work as rapidly as possible. A new idea originating with the R&D organization might be passed to the project office, from there to North American, and on to a subcontractor in less than a day.

"The system is working well," NASA reports.

The project office attempts to maintain a single, clear point of contact for each outside organization, whether it is a contractor or another NASA group at Marshall, Goddard or elsewhere. A series of working panels are set up for day-to-day contact with Marshall Space Flight Center on interface problems. These cover such areas as electronics, flight dynamics and operations. Contractors are called in as required.

Apollo procurement at Houston is carried out under David W. Lang, chief of procurement for the Manned Spacecraft Center. An *Apollo* procurement office is set up in MSC's Procurement and Contracts Division specifically for support of the spacecraft project office.

Most dealings of the *Apollo* procurement office are with major contractors such as North American and the guidance and navigation contractors. It is, however, buying some smaller items such as transducers and telemetry packages for R&D instrumentation for the initial *Little Joe II Apollo* tests.

• **Making contact** — How can an interested supplier determine whether to contact Houston or North American Aviation?

"If the item is an integral part of the spacecraft, sell it at North American," says procurement director Lang. "If it is something that is, say, a better system than one we already have contracted for—a better way of doing it, a breakthrough—then come here."

Initial point of contact at Houston for new firms wanting to get into the program is the Small Business and Industry Assistance office in Lang's organization.

Submission of a Form 29 request to be put on the bidder's list should be sent to this office. It also is the receiving office for unsolicited proposals, which it farms out to the pertinent technical group. If interest is aroused, the Industry Assistance Office arranges the appointments.

"Unless you have something to offer, you are wasting your time in coming here," Lang warns. "This is no place for a shopping expedition. The things we are doing are pushing the state of the art. If you don't have the background, experience and facilities already, it will be difficult to compete. If people have something to benefit this program, we want to know about it. But we don't want to listen to just a sales pitch." ⌗

Marshall Awaits Results of Review

Working panels from the Center and Houston meet to solve interface problems; uncertainty surrounds Nova

MUCH of the *Apollo* activity at Marshall Space Flight Center now is awaiting the comprehensive review by NASA Headquarters of the entire Manned Lunar Landing program.

From this study are expected to flow definite guidelines on the techniques and hardware which will be used to accomplish the *Apollo* mission. Meanwhile, Marshall is proceeding with the organizational and technical definition of the *Saturn C-1* and *C-5*—although a stop-order has been put on the selection of two contractors to conduct detailed systems definition and preliminary design of the *Nova*.

Organization, particularly to meet the *Apollo-Saturn* interface problems, is one of the most critical areas in the program. To solve this problem, Marshall and the Manned Spacecraft Center at Houston have established working panels from the operating divisions of each Center.

These panels meet, when necessary, to define and solve technical problems. If a solution cannot be found at this level, the problem goes to a review board co-chaired by the Directors of the two Centers, Robert R. Gilruth and Dr. Wernher von Braun.

For example, a current working panel—consisting of representatives from Marshall, Houston, North American, and the soon-to-be-established Launch Operations Center—is meeting to determine the ground equipment needs of the *Apollo* spacecraft.

In about three months, according to Marshall engineers, the preliminary design of the ground equipment should be defined sufficiently so that work can begin on such long-lead-time items as the umbilical tower at the *Apollo* launch site.

The same principle of working groups exists in the Saturn Systems Office, where eight such panels have been established. These groups consist of representatives of the applicable Marshall division and contractor personnel with a representative of the Saturn Systems Office in attendance. Once a change in the vehicle or stage design is determined to be desirable, the contractor is notified officially by the Saturn Systems Office. Discussion and determinations by the working groups are not, in themselves, a basis for action.

• **Saturn C-1**—Starting with *SA-5*, the *Saturn C-1* flights will carry increasingly sophisticated *Apollo* command-module prototypes, in order to provide an orbital test bed for the spacecraft systems. The *C-1* will also be used to test the heat protection equipment on the comand module.

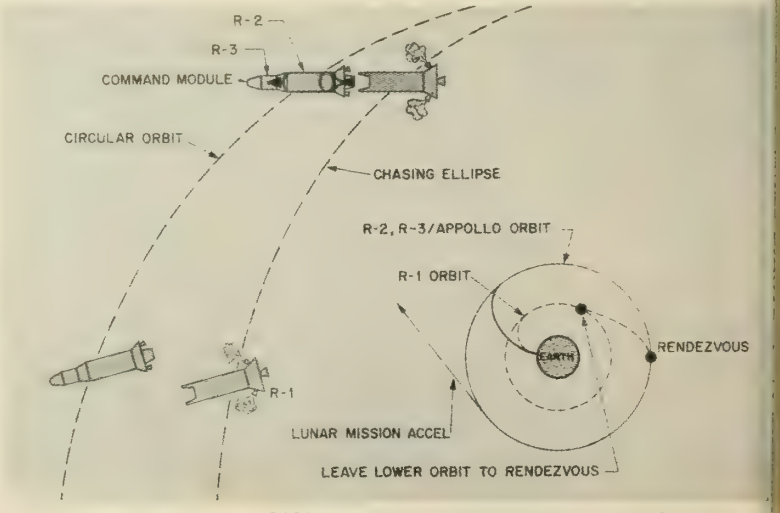
By using a high-speed re-entry trajectory, the two-stage *Saturn C-1* will be able to attain almost parabolic speeds of 32,000 fps. Returning to earth at this velocity will subject the capsule to approximately the same temperatures anticipated in the re-entry phase of the lunar mission.

Although a decision has been made, that the *S-IVB* be used as the third stage on the *Advanced Saturn* in place of the presently planned *S-IV* stage of the *C-1*, implementation of the decision is being delayed until the *S-IVB* stage becomes available in 1964. The *S-IV* uses six RL-10A3 liquid oxygen/liquid hydrogen engines developing 90,000 lbs. thrust; the *S-IVB* uses one 200,000-lb.-thrust liquid oxygen/liquid hydrogen J-2 engine. The substitution, Marshall engineers say, will boost the payload capability of the *C-1* by 50%.

For guidance of the booster combination, the *C-1* will use an improved and modified ST-120—an inertial stabilized platform which grew out of the ST-80 and ST-90 platforms used on the *Redstone* and *Jupiter* missiles.

In addition to the *Apollo* test missions, Marshall has tentatively started planning to take over the missions now scheduled for the *Centaur* booster, should that system continue to have trouble. As one top MSFC official put it, there is a "good chance" that this may happen. If it does, Marshall wants to be prepared to fill the gap with the *C-1*.

• **Advanced Saturn** — Not as advanced in its development cycle as the



MOST LIKELY APPROACHES to orbital operations, under study at MSFC, are shown above. At left, typical

C-1, the *Saturn C-5* (a competition is being conducted within NASA to change the name of the vehicle to reflect its separate status) is still in the process of definition, and is intimately involved in the program review.

That the *S-IC, S-II* and *S-IVB* stages will be used on a *C-5* vehicle now seems to be beyond any doubt. However, the possible substitution of a nuclear third stage *(Saturn D)* is receiving serious consideration. Over $400,000 dollars is being spent by Marshall on four-month design studies by Lockheed and General Dynamics/Astronautics of a possible *Saturn D* configuration.

The operational availability of nuclear upper stages (1968-69), however, would seem to preclude their use for the initial *Apollo-C* missions. They are likely to be introduced into the program, though, as soon as they become available.

Of more serious consequence is the program review being conducted by the Manned Spacecraft Office in Washington. Conceivably, although Marshall thinks it unlikely, Headquarters could decide that the surest route to the moon is by direct ascent. Such a decision, of course, would result in a de-emphasis of the *C-5* and an acceleration to the *Nova*.

Marshall officials feel, however, that they can have an operational *C-5* at least a year or more before any *Nova* vehicle that is defined. This is mainly because of the long development lead-time of the M-1 engine just now getting started at Aerojet-General.

"We should not have to wait for the M-1," is the way one MSFC official put it.

Strong advocates of orbital operations, MSFC officials point out that rendezvous and docking operations do not have to wait for the *C-5*. The *Gemini* program as well as the *Saturn C-1* will have determined the feasibility and procedures long before the *C-5* becomes operational.

Marshall has recommended, they point out, that the third operational *C-1 (SA-113)* be an astronaut flight which would give ample opportunity to develop orbital operations procedures with the operational *Apollo-A*.

• **Nova**—Although a Phase I systems design and definition study was approved in March, Marshall early this month received instructions to hold up *Nova* work, pending the results of the program review effort.

Originally conceived as a back-up effort for the *C-5* orbital operations concept, *Nova* can go two ways, depending on the results of the review. If it is decided to make a direct ascent to the moon, it will be accelerated and optimized for this mission. This would give it a probable three-stage configuation—N-1: 8 F-1 engines developing 12 million lbs. thrust; N-2: 2 M-1 engines with 1.2 million lbs. thrust each and N-3 with one 200,000-lbs.-thrust J-2 engine.

However, if *C-5* gets the nod for the *Apollo-C* mission, Marshall officials feel that a *Nova* with a payload capability of a little over two *C-5* vehicles would not be a big enough step forward. Rather, they feel, the *Nova* should be sized for a mission beyond the lunar-landing mission.

However, one MSFC official cautioned that the decision as to whether we want a capability beyond twice the payload of the *C-5* is a National Policy decision. "We can afford to wait now," he said, "and it is in the best interests of both the government and the contractors to do so." He added, though, that, to have an operational capability in 1969, a decision would have to made in July.

Since the stop-order on *Nova* came shortly before the proposals were due for the preliminary design contracts, Marshall has received the five proposals, evaluated them and will be able to award the two Phase I contracts shortly after they receive a program decision from Headquarters.

• **Orbital operations** — Two approaches to orbital operations (depicted below) are currently receiving close attention at Marshall: connecting rendezvous docking and tanker rendezvous docking. Of the two, Marshall engineers seem to prefer the tanker method, because after the fueling operation most of the orbital rendezvous equipment can be ejected after the propellant is transferred.

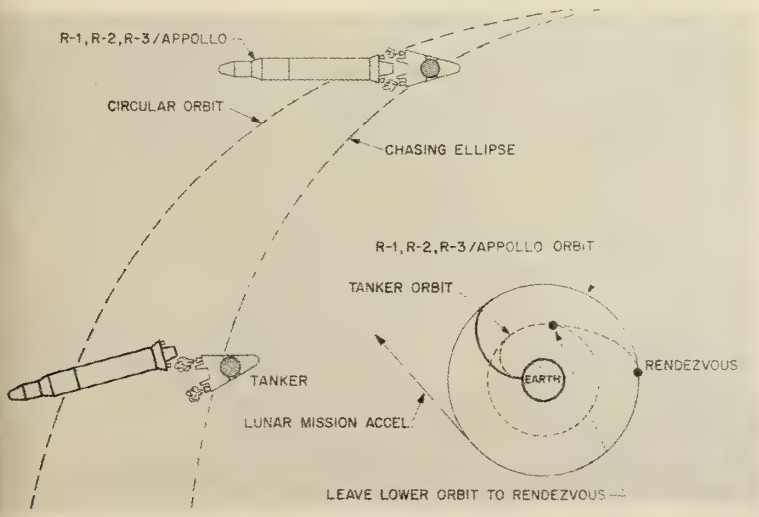
However, the transfer of cyrogenic propellants under zero-g conditions presents complex engineering problems. Two solutions proposed to solve them: creating an artificial gravity field for the transfer operation or using an expulsion bag for the propellant.

The latter seems to be the preferred method. Essentially, the expulsion bag acts like an ordinary balloon in that it is blown up by the propellant and, when the throat is released, the fuel is forced out by the action of the collapsing bag.

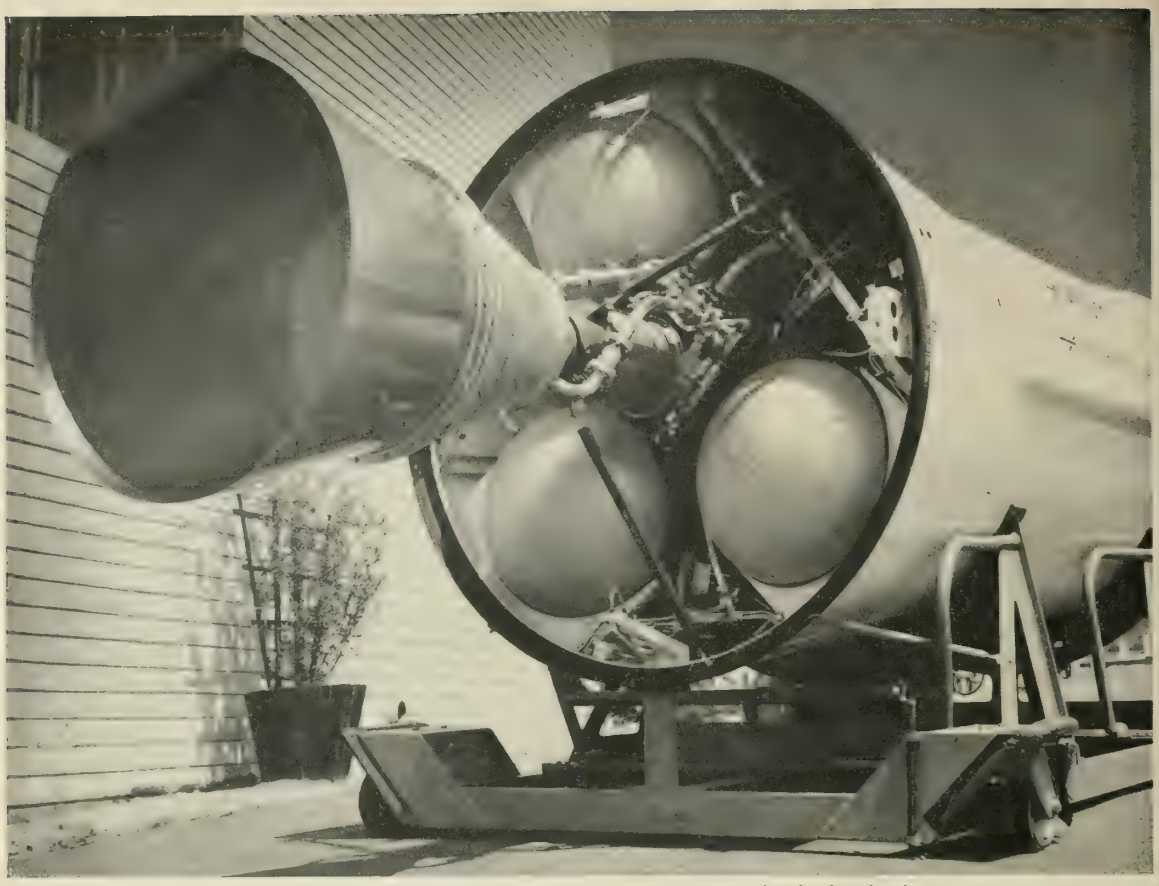
Briefly, the two orbital operations are performed by:

—Connecting Mode: R-1 stage injected into circular orbit by *C-5*, then *Apollo* spacecraft injected into a higher circular orbit. At a computer-determined time of coplanar orbits and proper phasing, the R-1 stage is commanded to commence rendezvous manuevers. Thrust applied to the R-1 causes it to ascend in an elliptical path to the spacecraft. Within about fifty meters of the spacecraft the crew would take command for the final docking maneuver. The R-1 stage accelerates the spacecraft into a lunar trajectory and then is discarded.

—Tanking Mode: The tanker containing the oxidizer (LOX) is launched into a low circular orbit. A second C-5 then launches the *Apollo* spacecraft and the R-1 stage minus oxidizer into a higher circular orbit. The rendzvous is accomplished as in the connecting mode. The tanker then transfers the oxidizer to the R-1 stage and the spacecraft is injected into its lunar trajectory as in the connecting mode. ⁂



connecting rendezvous docking. At right, typical tanker rendezvous docking. Latter seems to be favored for Apollo.



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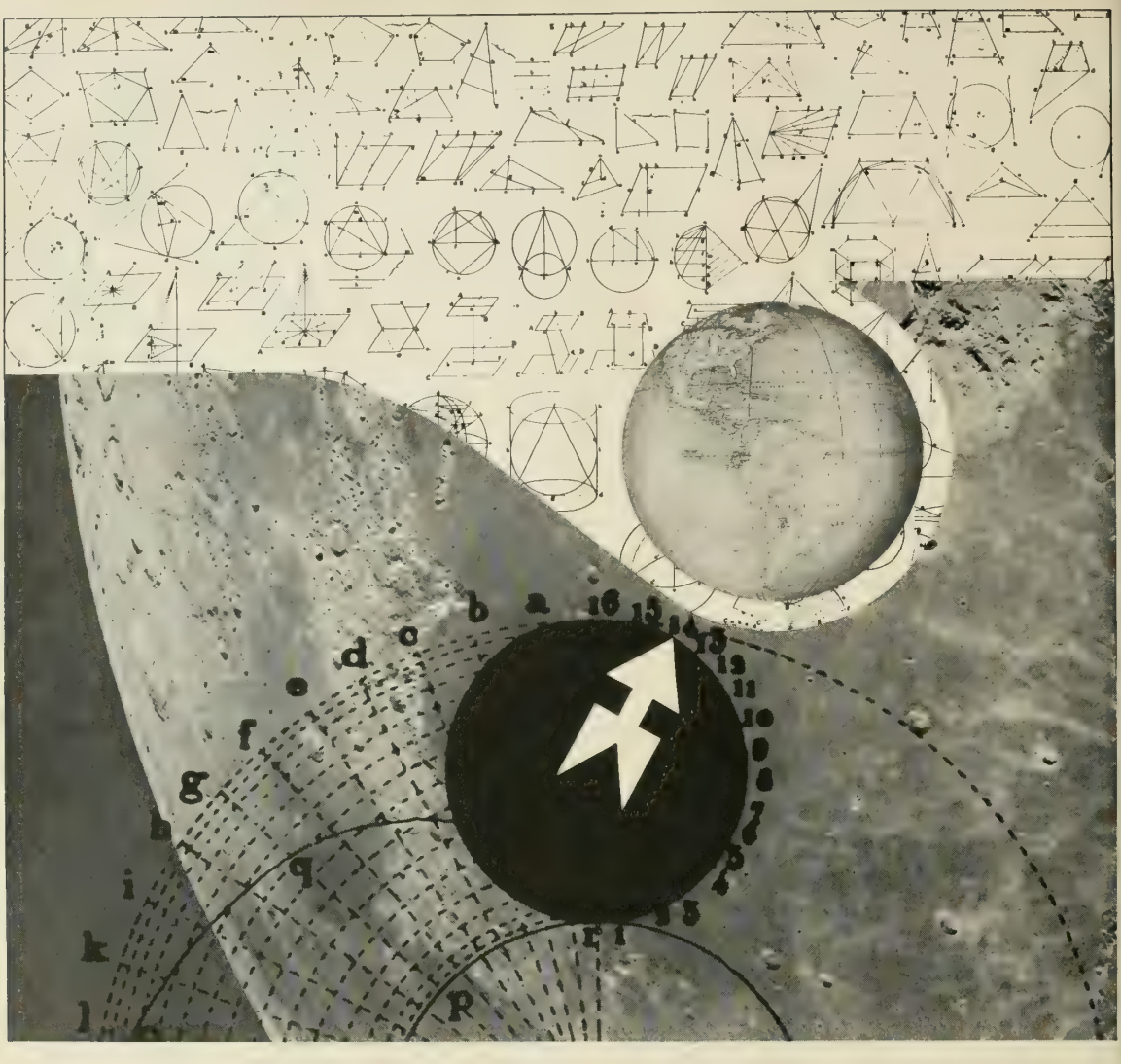
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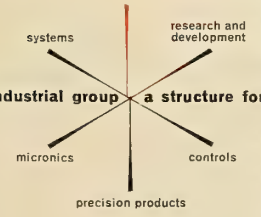
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MIT Helps Manage Guidance System Effort

A.C. Spark Plug, Raytheon, Kollsman, Sperry Rand form industry team for program to cost over $100 million

MASSACHUSETTS Institute of Technology and four industrial contractors are gearing up for the major effort to develop the *Apollo* spacecraft's guidance systems at an estimated total cost of more than $100 million.

NASA has already asked Congress to approve $32 million in Fiscal 1963 for the system. NASA officials estimate that in Fiscal 1964 this will increase slightly—to perhaps $40 million.

The value of MIT's contract approximates $20 million. This, however, covers only the Earth-orbital phase of the lunar-landing program. Other tens of millions of dollars will be needed for the circumlunar and lunar-landing guidance systems.

The same boost in contract value applies to MIT's industrial support team. A.C. Spark Plug Division of General Motors was recently awarded a $16-million contract to build the inertial platform for the system.

It will also build a ground support and checkout system, and will assemble and test all components. Under a separate award, the firm is also building all required gyros.

Raytheon Co. has a $2-million contract to manufacture the system's onboard digital computer. Kollsman Instrument Corp. will build the optical subsystems—including a space sextant, sunfinders and navigation display equipment—also at an estimated cost of $2 million.

The fourth firm in the industrial team is Sperry Rand Corp., currently building the system's accelerometers.

NASA expects to add no new firms to the guidance industrial team. This will hold true, NASA officials report, except in an instance when the four firms may not be able to supply a future technical requirement.

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MIT'S Instrumentation Laboratory.

• **Subcontract prospects**—The completion of the major contracting team for the guidance system means that the opportunity for other electronics firms to take part in the system's development now rests completely in the subcontracting area.

Since the industrial team was only selected on May 9, the actual letter contracts have not been signed. Selection of subcontractors of the major contractors will begin in the next few weeks.

The four firms will build 10 test-flight systems for the Earth-orbital phase alone. Additional systems will be built for the circumlunar and lunar landing flights in the *Apollo* program.

MIT's current contract for the first year's work on *Apollo* runs to just over $4.3 million. Its value will step up sharply in Fiscal 1963 and 1964.

Though plans for scheduling development of the *Apollo* guidance system are still very fluid, it is estimated that a half-dozen test and evaulation and engineering prototypes will be fabricated by MIT. Some of the engineering prototypes are also likely to be flyable. MIT will do some outside component procurement for these early systems, but the bulk of the work will be in-house.

• **Assignments** — Overall responsibility for the spacecraft's guidance and control system rests with the Manned Spacecraft Center (MSC) at Houston, Tex., which evaluates and awards all procurement contracts.

MIT provides, in conjunction with MSC, system management for the guidance and navigation package. It has direct access and authority over the technical aspects of the contract.

North American Aviation Inc. is responsible for establishing the interface between the guidance system and the spacecraft. During the tests of the system at North American and Cape Canaveral, the industrial contractors will provide test personnel. MIT will have supervision of the test.

Major responsibility, thus, rests with MIT.

Dr. C. Stark Draper, Director of MIT's Instrumentation Laboratory, declares that MIT's management of the guidance system development is set up on a strictly functional project basis.

"If something is wrong," he says, "We know exactly who to go to."

"By the same token," he asserts, "the men responsible have the real power and authority to get the job done." ⌘

At Mississippi, Canaveral . . .

Test Stands, Launch Pads Planned

Many millions to be invested in Pearl River complex for static tests; NASA fights to get back Nova pad funding

SIXTEEN TEST STANDS will be built at NASA's Mississippi Test Facility for the static testing of Project *Apollo's* launch vehicles and rocket engines.

At Cape Canaveral, eight launch pads will be constructed to send the boosters and their three-man spacecraft payload on a variety of manned lunar-landing missions.

The two installations—along with NASA headquarters, Marshall Space Flight Center, and the Manned Spacecraft Center—round out the space agency centers with prime roles in the manned lunar landing program.

The Mississippi facility will be operated in conjunction with Marshall and the Michoud booster operations plant. Now just a lot of swampy land in Mississippi and Louisiana, it will be transformed in the next few years into a valuable piece of real estate with facilities worth well over half a million dollars.

• **Mississippi**—The test stands at the Pearl River site will service the *Saturn, Advanced Saturn, Nova,* and *RIFT* launch vehicles and the F-1 and M-1 liquid engines. It is also expected large solid boosters will be test-fired there when they are developed.

The test stand plans:

—At least three stands will be built for the *Advanced Saturn* first-stage booster which will be powered by five F-1 engines. Because of the heavy firing plans for the big booster, it is expected that two and possibly three more stands will ultimately be built.

Space agency officials have already asked Congress for funds to build the first *Advanced Saturn* test stand and to make a start on the second.

—Five test stands for the first and second stage of the *Nova* superbooster will be constructed. Two will test-fire the 12 million-lb. first stage and two are required for the two M-1-engine second stage.

The fifth will be capable of testing both stages. NASA has asked for $43 million in Fiscal '63 funds and the total cost will be about $200 million.

—Two stands will be built for each of the *Saturn* boosters. No money has yet been requested for the four stands, but these will not be needed until the 1964-65 period when the first *Advanced Saturn* vehicles start to roll off the assembly lines at the Michoud plant.

—A NASA map of the facility which was part of the Fiscal 1963 budget presentation shows a site for a test stand for the nuclear-powered *RIFT* upper stage. Earlier, it had been expected that *RIFT* would be test-fired at the Atomic Energy Commission facilities in New Mexico, but space agency officials apparently have decided to do the testing close to the Michoud plant.

—Possible other test stands at Pearl River include the *Advanced Saturn* second stage powered by five J-2 engines and large solid boosters of up to 20 million lbs. thrust. No funds for these sites have been requested as yet.

—Test stands for the F-1 and M-1 engines are also planned, but a final decision has not been made as to just where they will be located. Funds for the stands are in the Fiscal '63 budget, but it is possible they will be built elsewhere.

The Mississippi Test Facility will be directed by the Marshall Space Flight Center under Dr. Wernher von Braun. It will be responsible for its management, funding and procurement.

No procurement has yet been initiated. It will begin as soon as the space agency's Fiscal '63 budget is approved by Congress.

The *Advanced Saturn* test stands will be designed to mount the booster firing vertically downward into a water film-cooled jet handling equipment, on-stand propellant supply system piping, on-stand deflector cooling and fire protection water piping, personnel and freight elevators, on-stand instrumentation and control wiring, termination rooms, ducting and special equipment.

The *Advanced* site will also require an Instrumentation and Control Center, Test Support Building, Observation Bunkers, High-Pressure Water System, Propellant Ready storage and handling facilities, high-pressure gas storage and instrumentation and control equipment including analog and digital computers.

The equipment and facilities for the *Nova* test stands will be similar.

• **Cape Canaveral**—NASA plans for the Atlantic Missile Range received a sharp blow recently when the House Space Committee refused to approve an $80-million authorization for construction of *Nova* launch pads.

The agency plans to build three *Nova* pads, four *Advanced Saturn* pads and one launch pad for a solid rocket to be used for suborbital flights of the *Apollo* spacecraft.

NASA will attempt to get the Senate Space Committee to restore the *Nova* funds. If this fails, the space agency is expected to request a supplementary Fiscal '63 authorization early next year.

NASA activities at Cape Canaveral recently became a full-fledged field center. It is known as the Launch Operations Center. Under the direction of Dr. Kurt Debus, it now handles all of its own procurement.

A new procurement office, headed by Gerard Michaud, has been set up. Procurement of a vertical assembly and checkout building, an *Advanced Saturn* launch pad with associated propellant system, a rail transfer system and two rail-mounted launcher transporters will begin as soon as the Fiscal '63 budget is approved by Congress. ⌗



EHR was developed by Texas Instruments, working with Douglas Missiles and Space Systems Division, prime contractor to NASA for the Delta space vehicle program. EHR helps assure the success of programs such as the TIROS II, shown here boosted by the NASA/Douglas Delta space vehicle.

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A new concept in semiconductor reliability has evolved f Douglas Missiles and Space Systems Division's and the Nati Aeronautics and Space Administration's determination to as 100% systems success in Delta space vehicles. This conc termed **EHR** for Extreme High Reliability, is concerned at pre with orbital and deep space probes launched by the Douglas-l Delta. Texas Instruments engineers worked with NASA Douglas personnel, beginning with a complete re-examinatio current manufacturing philosophies . . . all the way through helping establish the systems reliability standards. In esse this program defines **EHR** as "building-in quality in additio testing for it." **EHR** had to be much more than just ano testing program, for testing the finished product cannot guara the conditions under which it was made. To provide NASA Douglas with "Space-Quality" parts, Texas Instruments bega evaluation procedures by multiple 100% inspections during p essing and 100% inspections by the independent Quality Reliability Assurance department to assure creation of a devic nearly free from any flaw as is humanly possible. **EHR** quality trol procedures include microscopic inspection at each stag manufacture, beginning with materials and parts inspections be the assembly process is started. Assembly is performed in trolled atmosphere, under positive pressure to help ensure elimination of all foreign material. Even the jigs used to hold devices throughout the assembly processes are subject to same microscopic scrutiny as the devices they carry. ■ These but a few points in the **EHR** program, developed jointly by N Douglas and Texas Instruments. A partial list of tests given devices AFTER manufacture are listed below. ■ **Particle Dete** — This test checks for possible foreign material (internal

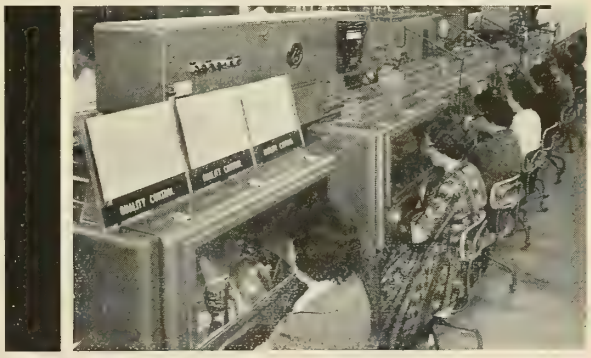
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s, solder balls, etc.) in the encapsulated unit. This method a vibration table set at 10 g zero to peak in conjunction with ezoelectric accelerometer, electrical filter and oscilloscope, the accelerometer mounted in a special fixture designed to it directly against the can. This test detects metallic contami- on weighing 9 micrograms or greater. ■ **Constant Acceleration**— purpose of this test is to demonstrate the mechanical endur- e of the device under extreme but nondestructive conditions. ending on the device, each transistor is tested in the Y_1 plane a centrifugal acceleration of 5,000 to 35,000 g's applied to the ce (nonoperating) for one minute. ■ **Operating Test**—Since the 250 hours of device operation are the most critical, the "Power n-In" test is performed on each unit to assure device stability. n device is operated for a minimum of 250 hours at $T_A = 25°C$ er full dissipation (P_C) condition. ■ **Dew Point** — This test is etermine if moisture is present within the encapsulated device. is monitored as the device temperature is varied from $T_A =$ °C to 25°C under operating conditions. Continuity with respect emperature must be observed in I_{CBO}. ■ **Vibration (Monitored)** his test establishes the device's electrical characteristics in nvironment similar to that seen in actual missile system appli- on usages. The device is subjected to vibration at 60 ± 5 cps minimum peak acceleration of 15 g's for a period of 30 sec- s. During the test, the forward voltage vs current characteristics monitored for flutter, shift, discontinuity, ringing or other ability. ■ **High Temperature Test (non-operating)** — This test o determine the stability of the devices electrically after ele- d temperature conditions. The transistors are stored at an ient temperature of 200°C ± 5°C for 250 hours minimum. **-RAY** — X-Ray is used to test for foreign particles and to assure uniformity of construction. ■ **EHR** is an all-out effort by Texas Instruments to achieve the long-sought goal of providing the Systems Designer with "Space-Quality" parts, i.e., devices approaching 100% reliability. ■ You can give **your** circuits semiconductor reliability far in excess of that previously available. You can specify devices produced under all of TI's **EHR** techniques or only those applicable to your specific military or industrial needs. ■ The manufacturing techniques and testing that comprise **EHR** result from TI's depth of technological skills, plus the determination and willingness to meet every TI customer's requirements. Today, more than ever before, in service, reliability and experience, you can rely on TI.

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The basic concept of EHR is "building-in reliability in addition to testing for it." Pictured above is an EHR semiconductor line at Texas Instruments. Each EHR device is subjected to repeated 100% microscopic inspection under positive pressure, controlled atmosphere by TI's independent Quality and Reliability Assurance department.

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Biggest Industrial Contractor Is North American

Company is prime for Apollo spacecraft and will build Saturn S-II stage; management know-how key to selection



TOP-LEVEL NASA and NAA officials meet at Downey, Calif., NAA office. North American President Storms is at far left, next to NASA's Robert Gilruth.

NORTH AMERICAN Aviation, with prime contracts for the *Apollo* spacecraft and the *S-II* stage of the *Saturn* booster, is the largest industrial contractor in the manned lunar program.

Under President Harrison A. Storms, Jr., NAA's Space and Information Systems Division already is well along in establishing the management and procurement structure for its share of the *Apollo* program. Another company division, Rocketdyne, will supply engines for the *S-I B* and *S-IV B Saturn* stages and the first stage of *Nova*.

SISD is responsible for building and assembling four major sections of the spacecraft: the launch escape system, command module, service module and the adapter section which will link the craft with *Saturn*. The initial $400-million award is expected to expand to well over $1 billion in the next five years.

• **2500 subs**—A large share of the procurement dollars going to NAA will be passed on in the form of subcontracts. Traditionally, the company has contracted more than half of its work. This pattern will be followed in *Apollo*.

Ten of the major subsystem contracts on the *Apollo* spacecraft command and service modules already have been announced. Ten more will be let by the end of August to complete the major subcontract structure.

In addition, thousands of other firms will be brought into the NAA program on smaller items. Few of these contracts have been awarded yet.

Clarence Nelson, *Apollo* material manager, estimates the total number of firms eventually will reach as high as 2500.

• **Managing know-how**—The task of setting up the procurement and organizational structure to manage an operation of this size has required the resources of the entire SISD division, which is simultaneously engaged in design and early engineering of significant portions of the *Apollo* spacecraft and booster. It was, in fact, NAA's management capability to handle an assignment of such magnitude that played a major role in its winning of the *Apollo* awards.

President Storms has set up straight project organizations for the *Apollo* spacecraft and *S-II* programs, while throwing in a few new management tricks—such as stand-up briefings and early planning for PERT, an *Apollo* program requirement.

"We got excellent technical response in our subsystem bids," Storms says. "We got some of the best companies in the country interested."

NAA expects its major subcontractors, to the highest degree possible, to set up project-oriented internal organizations to handle their share of the program, carrying the program/project management philosophy throughout the subcontract structure. NAA resident management teams will be assigned to major subcontractors.

"No one has built one of these before," points out John W. Paup, division vice-president and *Apollo* program manager. "Therefore, it is tempting to say we have carte blanche on any technique of management. I don't think this is so. The danger is that this can become a heady business. I take the view this is really a tough job.

"We're going to have to make a lot of difficult decisions at all levels. Somewhere we will make mistakes. I'm trying to judge the ability of people in the program to withstand this difficult period ahead. We must give people the opportunity to grow—and if they don't, replace them. Our most important job now is getting the right people on the job."

Organizationally, SISD has put into the mission-oriented *Apollo* program those functions which require a large specific effort on *Apollo*. The project will draw on the divisional structure for the remainder.

The same pattern has been followed in the *S-II* program.

• **The buyers** — Procurement follows the same lines. Project procurement officials buy those items peculiar to the project. Commodity items common to all programs are purchased by the divisional procurement organization.

Apollo purchasing under materials manager Nelson has concentrated its efforts on subsystems and other major items. Subcontract areas are determined by a "make or buy" committee consisting of program manager Paup, vice president-manufacturing James Y. Cunningham, material director Howard Cathers, quality assurance director Scott Crossfield and administration director K. B. Gay. Decisions are based on dollar size of the procurement and importance of the item to the program.

Major subcontracts still to be let by *Apollo* procurement include those for voltage regulators, altimeter and rendezvous radars, static inverters, reentry and recovery batteries, internal and external motion picture cameras, telescopes, antenna systems and pressure sensors. These are significant contracts in dollar volume and complexity. They will be let before the end of August.

Nelson has established a central control manager in *Apollo* procurement as an initial point of contact for those suppliers interested in taking part in the program. This is Harry Hulley, Administrative Liaison, Apollo Material Dept., Space and Information Systems Division, North American Aviation, 12214 Lakewood Blvd., Downey, Calif., Phone — SPruce 3-0610. Hulley's job is to set up briefing sessions for prospective suppliers with the appropriate SISD engineers, quality control and reliability managers. Through this system, potential subcontractors can reach all the interested NAA technical personnel at once—saving both time and money. Some 56 of these briefings were held in March.

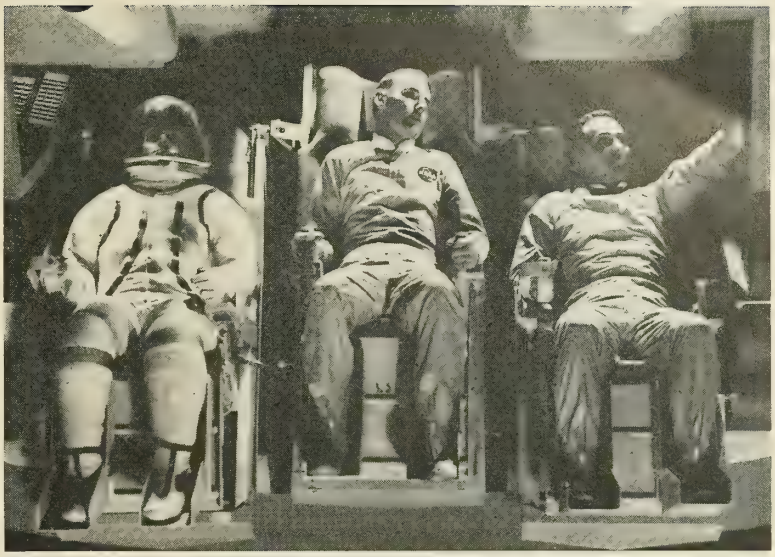
Companies then are screened sharply for qualification on the bidder's list—with strong emphasis on cost control and ability to meet schedules. NAA survey teams make plant inspection visits. Qualification results in an invitation to a bidder's conference.

"Our procurement is unusual in that the size of the contracts is such that we need the resources of the whole division—engineering, pricing, and so on—in placing them," says materials manager Nelson.

He notes that each of these subcontracts is equal in magnitude to many current prime contracts.

"We will have to rely on the management and integrity of the subcontractors—regardless of how many controls we put in," Nelson says. "We must depend on them not to pursue unpromising technical alleys or divert funds to other ends."

• **Screening**—For this reason, the



IN FULL SCALE mock-up of North American's Apollo spacecraft, three crew members occupy seats. One astronaut will be in commander's chair at all times.

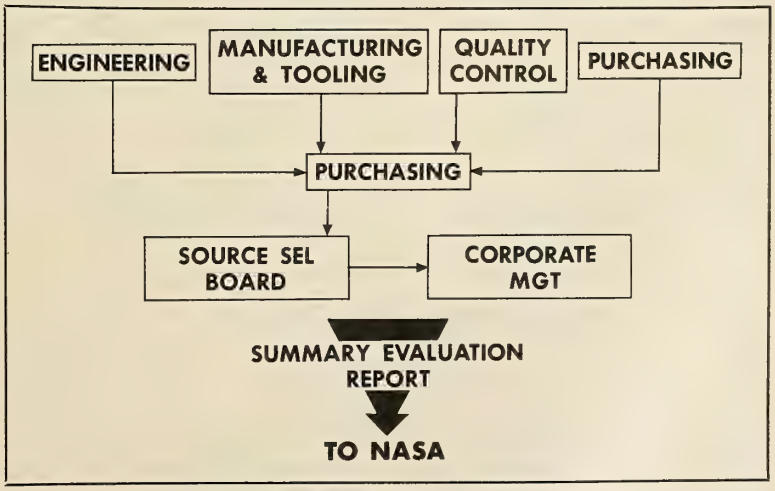


CHART SHOWS how North American selects sources.

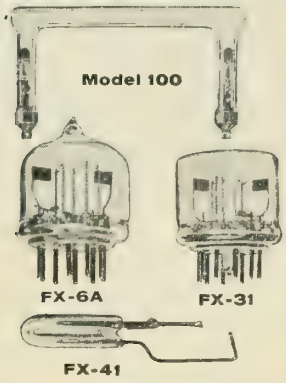
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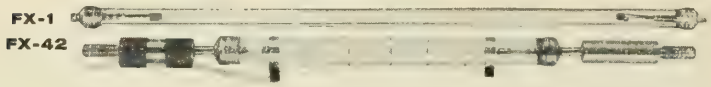


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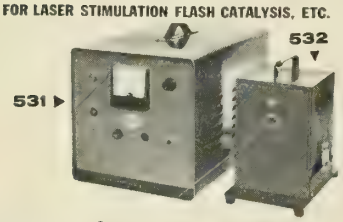
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SISD source selection board is made up of the division's top executive talent: president Storms, executive vice president H. R. Raynor, material director Cathers, applied science (engineering) director J. H. Cover, program manager Paup, quality assurance director Crossfield, manufacturing vice president Cunningham, logistics director R. J. Armitage, comptroller William W. Baker and director of administration Gay.

Decisions are based on an evaluation which covers technical design (750 points), technical capabilities (250 points), ability to produce (500 points), probable cost (300 points) and program management (200 points).

Divisional purchasing under material director Cathers buys commodity items for both the *Apollo* spacecraft and *S-II Saturn* stage.

"Even in division, however," says Cathers, "we may assign buyers on the basis of the project. This provides project attention even on the divisional level."

Cathers' department currently is contracting for facilities construction, office equipment, electronic components, tooling, hardware, machine parts, operating supplies and raw material.

"The small and medium-sized supplier can look forward to considerable activity here," he says.

• **First approach**—Initial point of contact with division procurement for interested suppliers is James Atkins, Small Business Administrator, Purchasing Dept., Space and Information Systems Division, Bldg. No. 3, 9150 E. Imperial Highway, Downey, Calif. Phone: WAlnut 3-7551, Ext. 3008.

Atkins' role is not limited to small business. He also sees larger firms and maintains an extensive source file for the division.

Companies contacting the divisional procurement office on *Apollo* are requested to write a letter outlining their capabilities on specifications which they manufacture.

"We take these letters and review them with other departments, particularly engineering," Cathers says. On items of interest, briefings are set up between the supplier and NAA.

"We are always looking for suppliers in every area of manufacture," the materials director reports. "We are never full up. We always are seeking new suppliers."

North American carries its thorough source selection approach even to small items in the program.

"All components look the same size when you think in terms of what will happen if they fail," Cathers says. ⁂

Signal Generator



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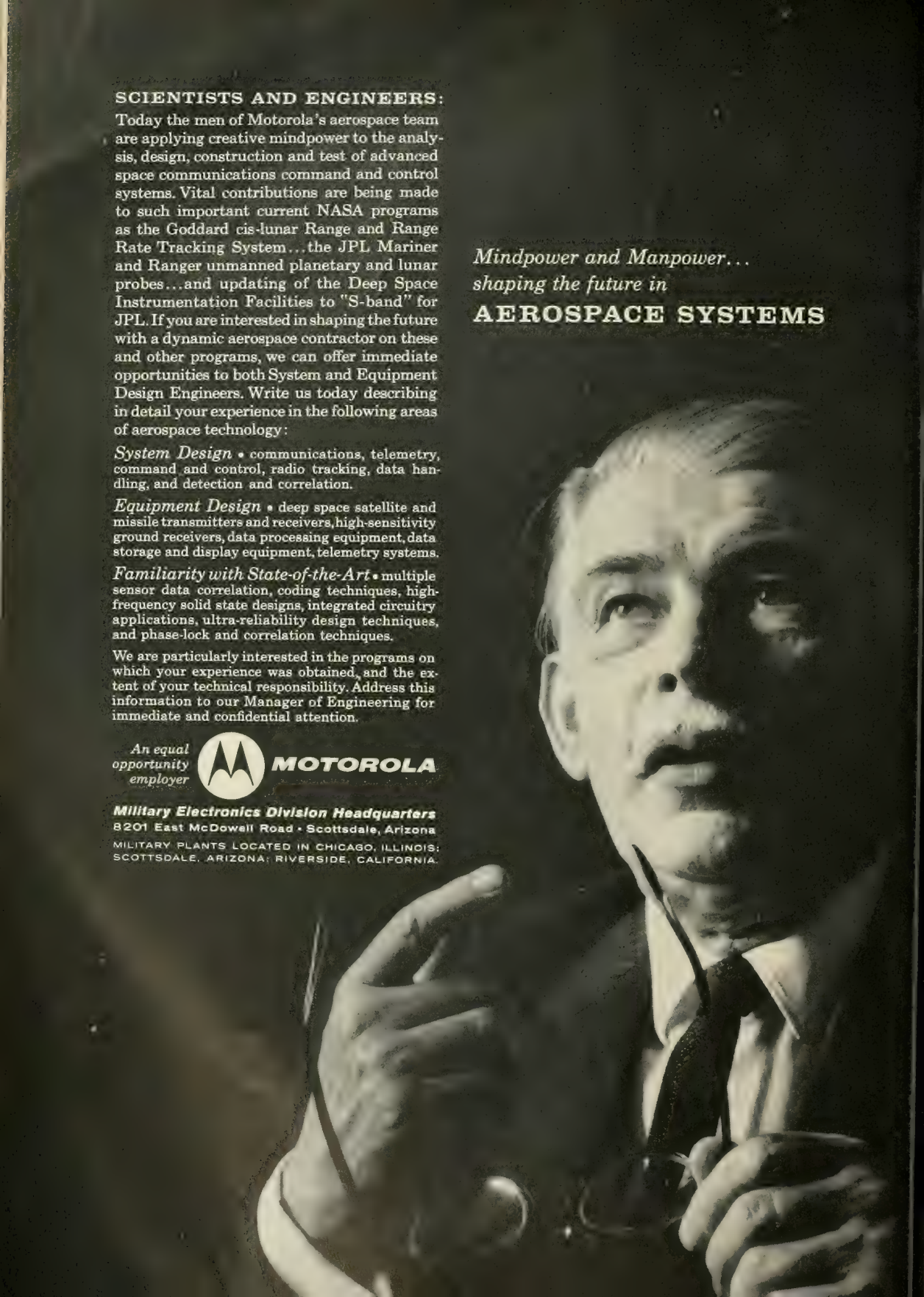
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SIZE DESIGNATION	PLUG O.D.	NO. OF COAXIAL CONTACTS	NO. OF POWER CONTACTS
A	⅜"	up to 7	up to 19
B	½"	up to 12	up to 37

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AERIAL VIEW of huge NASA Michoud, La., plant, where Chrysler will make Saturn S-1

Chrysler Prepares to Produce S-1's

Despite tight schedule, company sees no big troubles in phase-over from NASA; new subcontract opportunities emerging

A VAST, EMPTY World War II plant in cypress swamps near New Orleans soon will house Chrysler Corp.'s assembly operation for the *Saturn S-1* booster stage.

Chrysler's Space Division will share the 2.5 million square feet of floor space in the NASA Michoud Operations plant with Boeing Co. Boeing will utilize well over half the area for production of the *Advanced Saturn* first stage (see p. 54).

This week, Chrysler takes to Marshall Space Flight Center its final, detailed proposal for operation of the Michoud *S-1* facility. Under its present contract, awarded last Dec. 20, Chrysler has been preparing the facility, contracting for long-lead-time special tooling and equipment, and setting up the management organization to turn out 21 of the 82-ft. *Saturn* stages.

The first 10 research and development *S-1's* are being built by MSFC at Huntsville, Ala. This program is to be concluded in 1964 and the first Chrysler-built unit is scheduled for delivery in February of that year.

Many of Chrysler's Space Division engineers will continue to work at Huntsville until the *S-1* work there is completed, after which they will transfer to the New Orleans operation.

Only 450 Chrysler employees are now at the Michoud plant, situated 15 miles northeast of New Orleans on what once was a hunting preserve for French aristocrats. This number is expected to increase to about 2800 by the end of 1963. The division's employment of 1500 at Huntsville is expected to remain near 1500 even after the transfers to Michoud. In addition to these groups, Chrysler's staff at Cape Canaveral is expected to swell from the present 20 to nearly 200 by the end of 1963.

• **Tight schedule** — Space Division president James C. Smith, Jr., does not anticipate any major problems in the change-over from NASA to Chrysler production of the *S-1*. He points out that Chrysler and NASA have been through the same thing before, on both *Redstone* and *Jupiter*.

"They know how to do their part of this phase-over," he says. "We know how to do our part."

Admittedly, the schedule is a tight one. From a plant that now is bare, Chrysler must roll out the first *S-1* stage in August, 1963, to meet the Feb. 1, 1964, delivery date at the Cape.

"Our biggest job in the next eight months is in refurbishing this plant, filling it out with the special tools and assembly fixtures needed," says Smith.

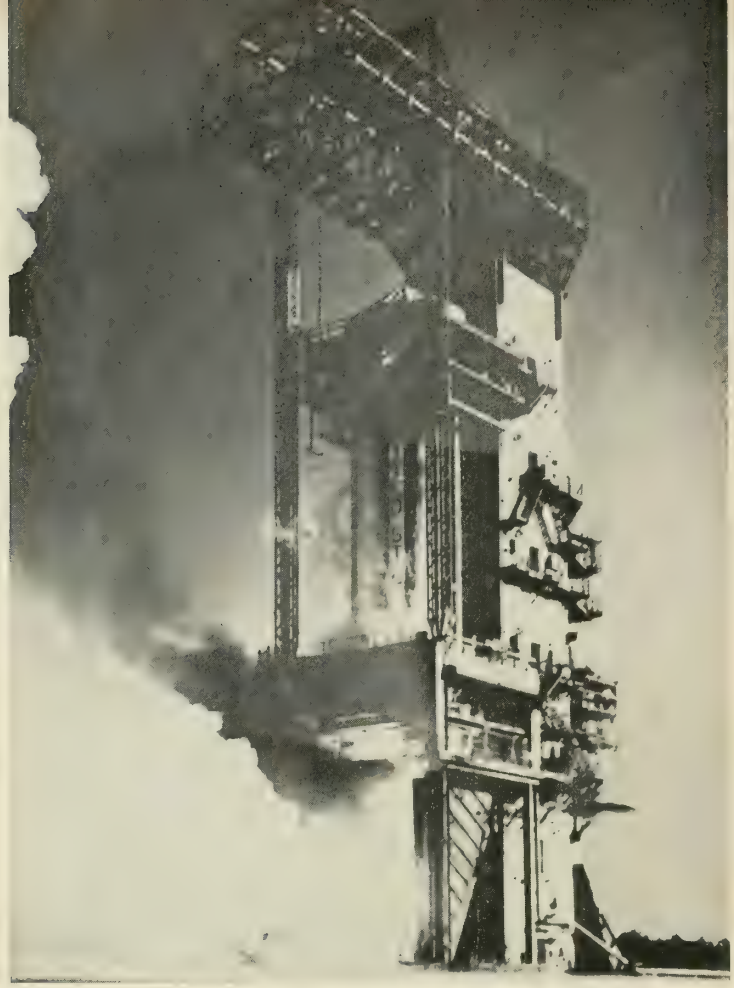
• **Opportunities**—Many of the subcontractors on the *S-1* program at Huntsville will, under present plans, become Chrysler subcontractors at Michoud. Ling-Temco-Vought will continue to turn out the tanks; Flexonics Corp., will supply the considerable tubing needed; Hayes International will continue to make the large rear engine shroud and the fins; A. O. Smith will provide the spheres for pneumatic support. The engines are Government-furnished equipment from Rocketdyne.

This does not mean a lack of subcontract opportunities on the program. Chrysler expects to go to second and/or alternate sources on medium and smaller components. It also will take a close look at the larger subcontracts.

"We will be looking for other sources," says director of materials John S. Gold, "both from the standpoint of cost and of new people to turn to in case the original supplier gets in trouble.

"You have to broaden the base of this so that if you do get into trouble you have someone to go to. I don't like it, and never have, to be tied to just one source."

The Space Division will build in-house the tail section with its barrel



SATURN FIRST STAGE built by Marshall Space Flight Center undergoes static test-firing. First Chrysler-built S-1 is to be delivered in February, 1964.

and outrigger assembly, the second-stage adapter, shroud for the adapter, fire walls and heat shield. It will carry out engine modification and systems assembly and the clustering and assembling of mechanical and electrical harnesses.

This will mean considerable activity in the next month on tooling and long-lead-time production items. The division also is just now beginning to generate purchase requisitions for product materials.

• **Searching for tools** — Chrysler now is surveying the government's industrial reserve pool of machine tools. The reserve is expected to be a major source; on one trip to government depots, however, a survey team selected only 8 or 10 after inspection of 100 machine tools. Chrysler will be authorized to buy those which cannot be found in the reserve.

Size of the stage has generated a requirement for large-scale tooling and equipment. For example, there will be 10 heavy bridge cranes in the final assembly area, seven more in the structures area and a number of smaller five- and two-ton cranes scattered elsewhere in the plant.

Among smaller items which Chrysler will buy from outside firms will be fasteners, valves, solenoids, accelerometers, pressure gauges, electronic components such as transistors, relays and diodes, and a considerable amount of component fabrication.

An increase in scheduling for the *S-1* stage would mean subcontracting of more basic work in order to create additional assembly room.

Facilities will be established in the plant for surface treating, plating, welding and machine shop work, with laboratories for evaluation, acceptance and testing.

"We are willing to talk to every supplier who is interested," says material director Gold. He suggests initial contact be made by letter to himself or to Harry Sinclair, Branch Manager, Purchasing Branch, Space Division, Chrysler Corp., Michoud, La. Phone: 242-2053.

• **Stressing reliability**—Strong emphasis will be placed on reliability, and the division will carry out extensive environmental testing. With minor exceptions, every piece of hardware will be tested before it flies in an environment that simulates actual flight conditions as closely as possible.

Vaino Vehko, director of engineering, and Edward Dofter, chief engineer of reliability, have developed a reliability program keyed to three specific milestones:

—They hope to obtain as much reliability information as possible on the fifth *S-1* stage built by MSFC, which will be the prototype of the *Apollo* configuration.

—They will do the same for the first Michoud-built stage, which is expected to be *SA-8*.

—The process will be repeated for the Chrysler-built vehicle which is scheduled for the first orbital manned flight, probably number six.

"Everything we buy will be tested at least once somewhere along the line," says Dofter. "It may be tested as a component, as part of a black box and again as part of a subsystem."

Proven components will be used wherever applicable, although they may have to be re-qualified for the new environment. Chrysler is also working closely with Marshall on previous *S-1* reliability qualification, to avoid duplication.

From an engineering viewpoint, Chrysler will not come strongly into the design side of the *S-1* until the first operational vehicle, whose designation will be the three-digit *SA-111* rather than *SA-11*.

The first four Marshall-built R&D stages are designated as Block I. First of Block II group will be an operational-type configuration. Under present tentative scheduling, Chrysler will build *SA-8;* Huntsville will build *SA-9* and then Chrysler will build all after that. But just how many vehicles Huntsville will build and at exactly what point Chrysler will phase in still is not finally decided.

• **Savvy team**—To meet a program which calls for barging of the company's initial *S-1* to Huntsville in the first week of August, 1963, and attainment of a one-a-month production rate by October, 1965, Chrysler has assembled an experienced team of missile and automotive production experts under President Smith. These include, in addition to those previously mentioned, vice president-operations H. Douglas Lowery, director of systems test Richard Gompertz, director of manufacturing John S. Sheldon and director of program control Bernard J. Meldrum.

Smith sums up the task when he surveys the bare 45-acre floor of the plant and comments "It's a tight schedule." #



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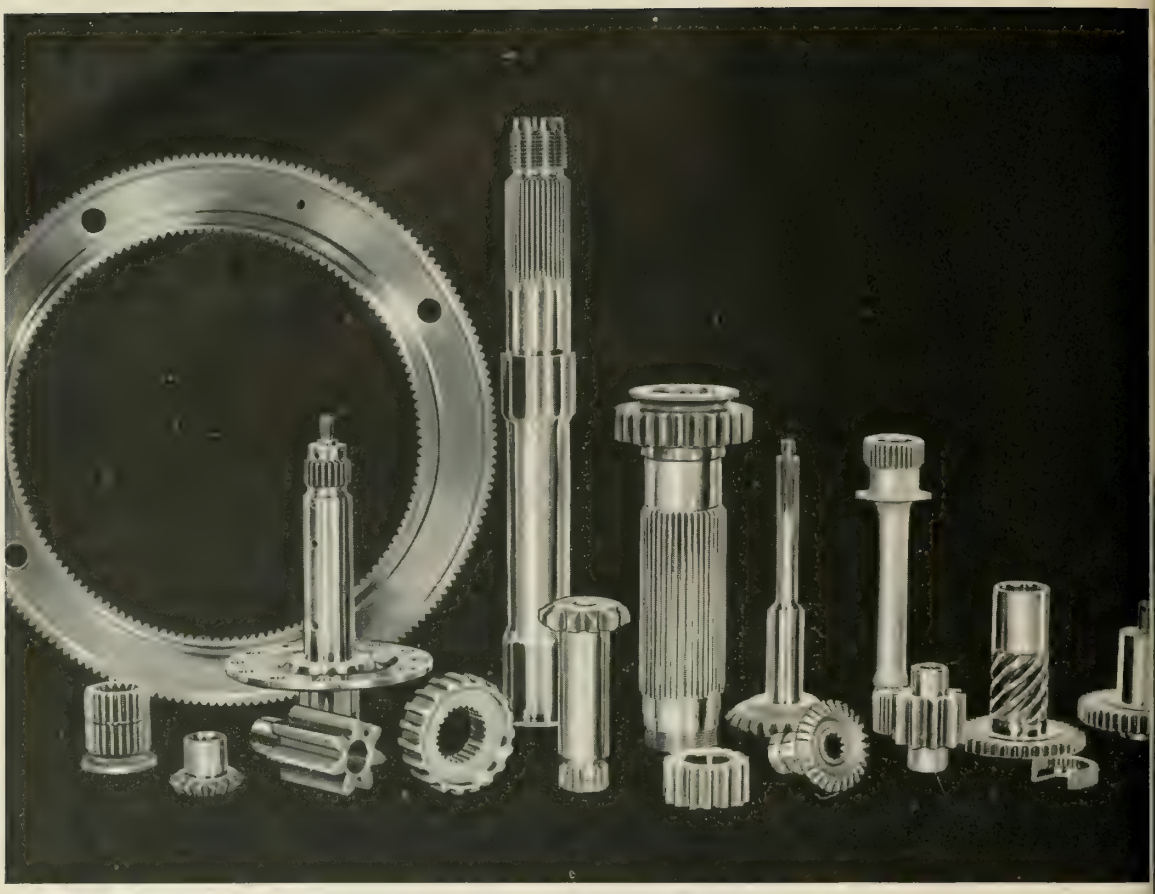
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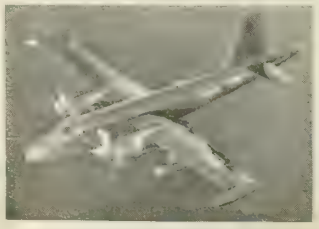


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Boeing Building 25 S-1C Boosters

For its first big NASA program the company has organized a management team spread across the nation

THE BOEING CO. will build 25 first-stage boosters for *Apollo's Advanced Saturn* launch vehicle at a cost of over $500 million.

Twenty-four will be flight test models, the other a dynamic test stand version.

The total cost estimate is based on NASA's calculation that a four-F-1-engine *S-1C* stage would cost $458 million. Since the stage has now been uprated to five F-1's with a total thrust of 7.5 million lbs., the value of the Boeing contract is sure to soar over the $500-million mark.

Ultimately, it is certain to climb still higher, because NASA plans a useful lifetime of 10 years for the big booster. Facilities capable of handling 32 launches a year are being built at Cape Canaveral for the launch vehicle, which will be operational in 1967.

To meet that schedule, Boeing has established a management setup which draws heavily on the organizational precedents of the company's Aero-Space Division.

The Saturn Booster Branch, however, is not a rubber stamp, scaled-down copy. It is probably even less a duplication of divisional management lines than its "sister" organizations—Space Systems Branch *(Dyna-Soar)*, Minuteman, Bomarc or Advanced Marine Systems.

A primary reason for the modification of divisional management lines is the need to adjust operations to program requirements established by NASA.

The *Saturn S-1C* booster is the Aero-Space Division's first NASA program of any major magnitude. NASA requirements are not radically different from those of the military, nor is the *S-1C* program any less complex than *Minuteman* and *Bomarc* or *Dyna-Soar*. But there are "differences."

One is the geographical spread of Boeing management for the *S-1C*. The same problem exists to a lesser degree with *Minuteman* and *Bomarc*. But Boeing does not have the higher echelons of its management for those programs spread across the nation on a semi-permanent basis.



GEORGE H. STONER
Boeing's Saturn booster manager.

For example, Saturn Booster Branch manager George H. Stoner holds top responsibility for Boeing's *S-1C* work at Michoud, Marshall Space Flight Center, NASA's Mississippi Test Facility and the Atlantic Missile Range. To keep him advised will require large management staffing at all those locations.

The largest *S-1C* management task will be at Michoud, La., branch of the Aero-Space Div. As general manager of the Michoud branch, Richard H. Nelson has executive responsibility for "effective and economical management" of all Boeing activities at Michoud and "other southeastern U.S. locations related to the *Saturn S-1C* program." Michoud also will be the assembly point for the *S-1C*, as well as other major portions of the *Saturn* system.

• **Building the crew**—Boeing has been picking *S-1C* management personnel since early in the proposal stages —long before the initial contract of almost $9 million was awarded. Since the contract was signed, over 600 persons have joined the *Saturn* team.

In addition to management, Boeing expects to have over 1400 people working on the program at various sites by July, and about 5000 on the *S-1C* work by the end of the year.

To further complicate program management, some *S-1C* work will be done at the Aero-Space Div.'s Seattle, Wash., plant and at Boeing's Wichita, Kan., plant. All these engineering, production, assembly and test areas, including those previously named, must be linked by management.

Key personnel have spent most of the early contract period at Huntsville on engineering details and contract definition. As the program gathers momentum with the award of a hardware contract, possibly next month, Boeing's *S-1C* operational accent will move towards Michoud. A rather small team has been there for some time.

• **Organization**—Stoner, as general manager, Saturn Booster Branch, reports directly to L. A. Wood, VP-General Manager, Aero-Space Div. Stoner's primary office will be at Michoud. R. H. Nelson, Michoud general manager, reports directly to Stoner as do H. J. Bebie, manager, Seattle Saturn Booster Program, and S. H. Stein, manager, Wichita Saturn Booster Program.

Seattle operations for the *S-1C* have been subdivided. Wichita operations are under study, to determine which *S-1C* operations will be assigned there. Both report to Michoud.

The Program Planning and Control Dept., under G. B. Larson, acts as Stoner's eyes and ears. Under this group, the Task Analysis Section holds a key role in selecting where work is to be done.

Another section of the department, Business Systems Section, is considered most important to the *S-1C* program and Boeing. This section determines and develops administrative systems.

Still another section of Program Planning and Control with an important function is the Program Planning—

Current Business Section. This group handles all phasing of *S-1C* work held under current contracts.

In something of a contradiction to contemporary corporate management concepts, Contract Administration is relatively small. Some of its normal functions have been split off into Program Planning and Control for tighter supervision.

Boeing is making a serious effort to eliminate or minimize the tendency to "projectize" everything — an approach that seems to be falling into some degree of disrepute these days. Its *S-1C* management concept is straightforward —even slightly conservative.

• **Procurement picture**—Under the initial NASA contract to Boeing's Aero-Space Division for the *S-1C* no hardware purchases were contemplated.

But the Aero-Space Division has developed a proposed procurement plan unlikely to undergo any major changes when a "go-ahead" contract is awarded.

A complete Materiel Branch has been established in the Saturn Booster Branch, Aero-Space Div., with responsibility for all procuring for all materials, parts, equipment, systems, subcontract work, services, supplies, and common-carrier transportation services needed by the *S-1C* program.

Boeing's standard procurement policies have been followed — modified somewhat, as in the case of its *S-1C* management program—to comply with certain NASA procurement standards and policies.

Most procurement will be made through the Michoud, La., facility, mainly because the major portion of Boeing's *S-1C* work will be there. Program portions that are slated for Seattle or Wichita facilities will be handled through Aero-Space Saturn Booster Program procurement offices at those plants.

The amount of *S-1C* assembly work scheduled for Michoud indicates that most end-item or component purchases, including complete systems and subsystems, will probably originate at Michoud.

Components for the propulsion stage, for example, might include individual components as well as complete systems. The S-IC Material Branch at Michoud would place contracts for these for delivery to Michoud, where Boeing takes over assembly of the units into the *S-1C* system.

Much of Michoud procurement is expected to be electrical and electronic systems, subsystems and components. The nature of many such items, and their application to the *S-1C* booster stage, makes it mandatory that Boeing maintain some control over the item purchased.

• **Dividing dollars** — At this stage of the program, it is difficult to say precisely where the most dollars will go. Most of Michoud's buys, from a straight numbers standpoint, will be in the aforementioned electric and electronic areas—both for ground checkout and airborne use. Other types of buys will be fewer in number—but still high in dollar value.

Preliminary *S-1C* "Make or Buy" thinking indicates that Boeing Wichita Div.'s long experience in metal fabrication gives it an in-house capability for much of the *S-1C* structural component work. Some extremely specialized metal work for *S-1C* structures will probably be contracted out to firms with special capabilities. Final *S-1C* stage assembly, however, will be at Michoud, which probably will be the procurement office for metal-type stage work not available from Boeing-Wichita.

Nearly all hardware or systems for the five-engine *S-1C* will be purchased, excluding the government-furnished Rocketdyne engines. Specifics in this category to be procured include propellant and oxidizer pressurization and loading systems. Again, Michoud probably will be the procurement point. Some propulsion stage systems also may be purchased as end items.

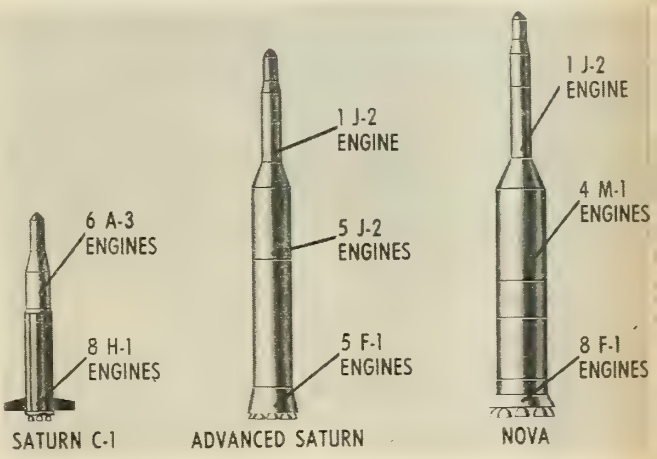
Major end-item buys are expected in communications and tracking equipment, with emphasis on telemetry. A good bit of equipment planned for the *S-1C* in these categories, however, will be government-furnished equipment (GFE).

In the electrical and electronic categories, Boeing will procure components that are not necessarily unique, but the Saturn Booster Program Materiel Branch will require some specific monitoring of component design and fabrication to assure that special *S-1C* requirements are met and that the components are compatible in the total system.

A major area of *S-1C* procurement will be checkout equipment, although much is GFE. Again, Michoud will be the primary procurement office for these components—considering the latter a description of a purchase, be it a system or subsystem. Most of the checkout equipment will consist of various test sets and calibration units. Some will involve computers and various types of simulators. Problem of systems integration for this equipment also requires some contractor control by Boeing. A very small part of checkout equipment will be purchased as end items.

Additional items for GSE, other than checkout equipment, include that necessary for stage launch transportation. About one-third of the necessities in this category will be GFE. The balance appears to fall well within the capabilities of Wichita. The fair-sized launch-and-transportation procurement from industry may be an end-item buy for an air-conditioning unit to be used during stage transport.

• **Standard procedure** — There's nothing exotic about Boeing's *S-1C* procurement plans and requirements. It follows the approach of securing bids from three or more competitive sources. Single or sole-source buys are frowned upon, and require very special justification. Contracts will be fixed-price whenever possible, but price redetermination, cost-plus-fixed-fee, time-and-material and other types may be arranged.



COMPARISON of Saturn C-1, Advanced Saturn, and Nova.

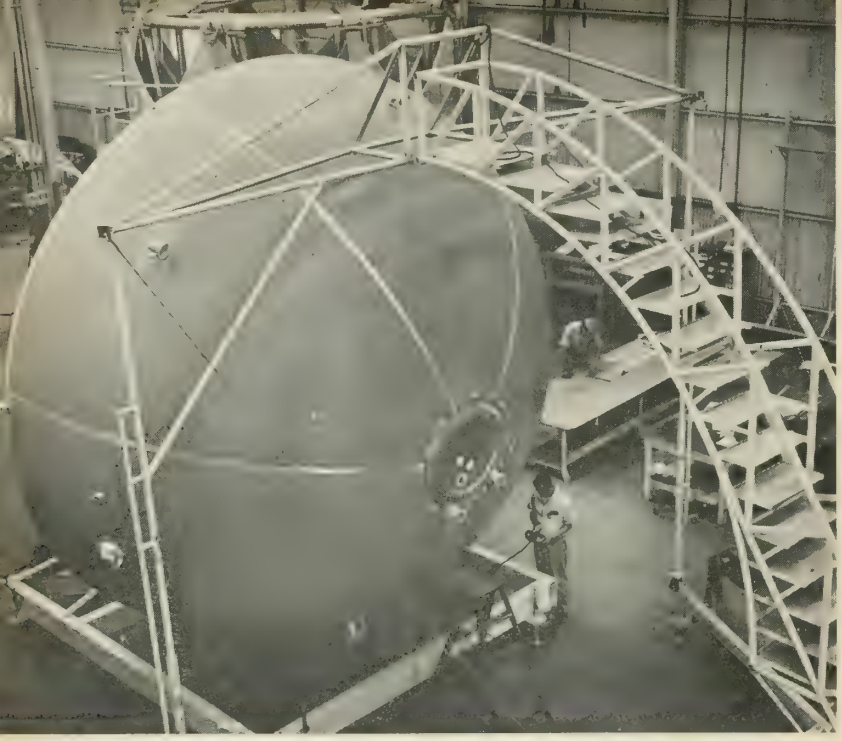
The Boeing *S-1C* procurement group structure is divided into three major areas: Airborne Procurement, Ground Support Procurement and General Procurement.

—*Airborne Procurement* — Responsible for items, purchased or subcontracted, which are booster parts airborne in the immediate post-launch period. This group will also procure special test equipment, spares, logistics data, and some tooling.

—*Ground Support Procurement*— Responsible for items, purchased or subcontracted, required on the ground to assist operational use of the *S-1C* booster as designed.

—*General Procurement*—Responsible for purchase of all raw materials and standard parts. In addition, this

(Continued on page 74)



KING-SIZE COMPONENTS of Saturn's S-IV stage include this 18-ft-dia. bulkhead. The stairway provides technicians with access to the top of the bulkhead.



TECHNICIANS at work on aft skirt section. Thrust structure is in left foreground.

S-IVB under design . . .

Douglas Busily Building S-IV Stages

Firms's Saturn management setup provides continuing group of administrators; S-IVB subcontracts likely

FABRICATION of the *S-IV Saturn* stage already is well under way at the Santa Monica, Calif., facility of Douglas Aircraft Co.'s Missiles and Space Systems Division.

The contract calls for production, testing and flight test of the second stage of the *C-1 Saturn*. Static test and acceptance firings will be carried out at the firm's Sacramento, Calif., test facility.

Douglas also is well into preliminary design of the *S-IVB* stage for the *C-5 (Advanced) Saturn*. This will draw heavily on *S-IV* technology and components. Production contract on the *S-IVB* now is being negotiated.

Program manager for the *Saturn* systems at the Missiles and Space Systems Division is H. M. Thomas. Reporting to him are the deputy program managers—for *S-IV*, Robert W. Prentice, for *S-IVB*, H. C. Foss.

• **Administrators in proximity**—Management of the *Saturn* programs at Douglas is not project-oriented. Under the *Saturn* program managers are program administrators assigned as representatives from each of the subdivisions of the division—materiel, manufacturing, engineering and others.

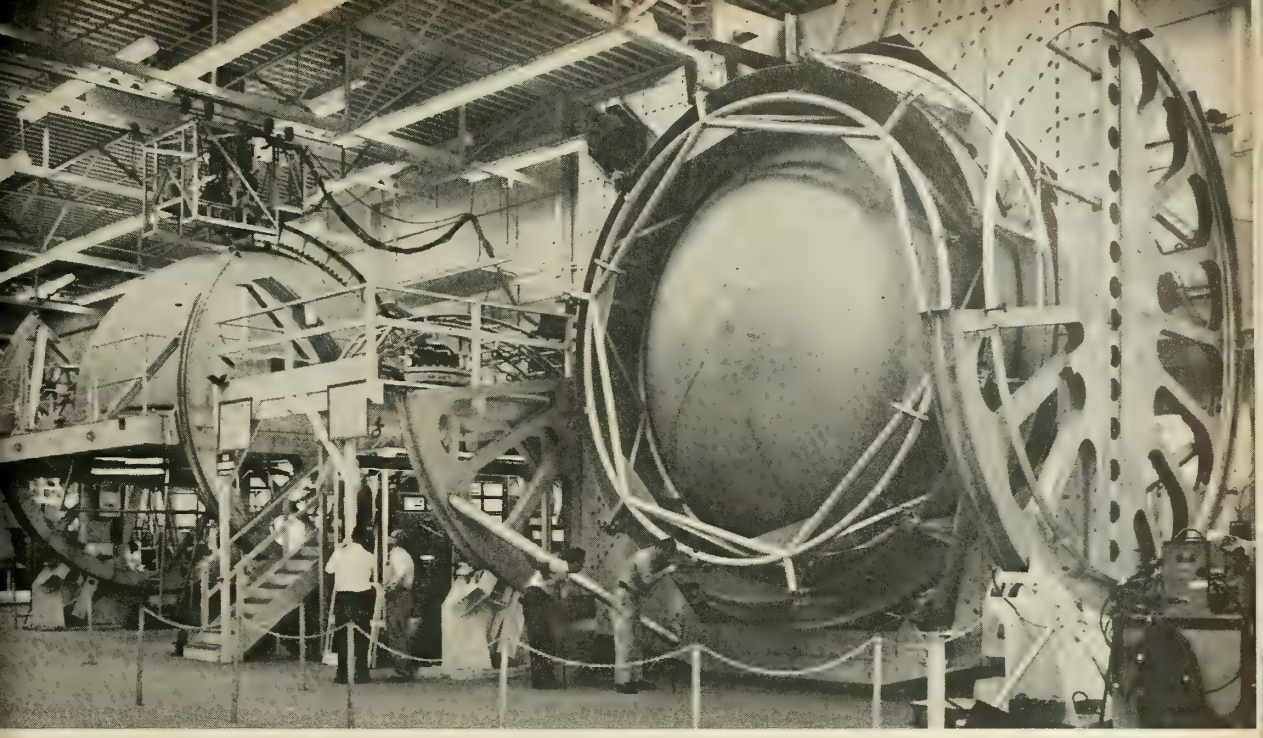
Although reporting administratively to his subdivision manager, the program administrator sits physically in the program office and receives his direction from the program manager.

"This provides at all times a group of people dedicated just to that program," says J. L. Sigrist, director of programs for the Missile and Space Systems Division.

At staff meetings on the *Saturn* program, the administrators are briefed on program changes and revisions. They then return to their own departments to coordinate the changes required.

"It's working very well," says Sigrist. "We have each of our programs set up this way and are proposing new programs on this basis."

Douglas uses this approach wherever a total system is not involved. The *Skybolt* ALBM, for example, is an exception.



12½-TON electronically controlled welding fixture is used for fabricating S-IV. Fixture precision-welds aluminum alloy segments into dome-shaped bulkheads. Positioned on inverted "basket," segments rotate past welding torch.

The materiel representative is well-briefed by sitting in on the program meetings, Sigrist points out in describing operation of this management approach. The materiel administrator therefore is well-briefed, understands the approach and urgency of the program office and can expedite the necessary action in his own department—often before the actual paperwork arrives. For example, the materiel representative may already have alerted buyers in the division before the orders are received from the program office.

• **Four fields** — Assistant program managers cover these areas:

— *Product Effectiveness.* This office has responsibility for establishing objectives for the total effort and for making sure that Douglas and its subcontractors have a balanced plan for reaching these objectives. Reliability, performance, value analysis, and logistics are among the aspects considered. Technically oriented, this office works closely with engineering.

—*Operations Effectiveness.* This group is responsible for monitoring and reporting on program costs, schedules, budgets and current status. It can recommend adjustments of Douglas or subcontractor program schedules.

—*Configuration Control.* This office maintains change-control of the program. It carries out a constant review of all changes affecting production of hardware and retrofit requirements. Control is maintained to reflect these changes in drawings, handbooks, manuals and technical data.

—*Plans.* The planning group stays out of today's problems and tries to anticipate those of tomorrow. It is looking ahead at the effect on long-range program requirements of new developments in system objectives and technology.

• **Subcontracting size-up** — The *S-IVB,* with its greater length and increased propellant capacity, will draw heavily on *S-IV* technology. But, while there were no major subcontracts on *S-IV,* Douglas anticipates there will be a few on *S-IVB.*

These probably will be in the electronics area on such items as the Propellant Utilization System and the Automatic Checkout System.

Substantial outside procurement is expected on *S-IVB,* due to its larger size and greater complexity. Firms already on the *S-IV* program admittedly will have an inside track on *S-IVB* procurement as a cost-saving measure, but Douglas procurement officials say:

"We are interested in competitive bidding on everything we can."

More rigid qualifications for the man-rated *S-IVB,* with its requirement for operation in orbit, will mean a heavier demand on subcontractors for reliability and environmental adaptability.

The *S-IV* subcontract structure is, of course, well established by now. The situation is just the opposite on *S-IVB.* Since Douglas is just firming up the design, there has been no procurement whatever and will not be for several months yet.

• **By commodities**—Materiel manager for the Missile and Space Systems Division is William E. Ferguson. Like the rest of the division, his department is not project-oriented.

"We break it down by commodities. We try to segregate allied commodities and put them in a buying section," he says.

Douglas will be buying for *Saturn S-IVB* raw stock, a number of individual electronic items such as relays, diodes, resistors and capacitors, valves, piping and some black box subsystems assembled to Douglas specifications.

Certain fabrication processes and machine shop overloads will be subcontracted. Some contract items—such as dollies and other equipment—also will be put out for outside manufacture on Douglas specifications.

For a company which has not previously done business with Douglas, Ferguson recommends initial contact by writing for a questionnaire on company capabilities. Requests for these should be addressed to: Edward Walker, Purchasing Dept., Missile and Space Systems Division, Douglas Aircraft Co., 3000 Ocean Park Blvd., Santa Monica, Calif.

"We see everyone who is interested, whether the need is immediate or not," Ferguson says. ⌘

Five Firms Share Some $600 Million

Rocketdyne heads list with F-1, J-2 contracts and Aerojet, Collins and Honeywell have other big awards

A TOTAL of almost $600 million is split among five missile/space firms other than the main spacecraft and launch vehicle contractors.

Leading the five is the Rocketdyne Division of North American Aviation, which has development contracts for the F-1 and J-2 engines—the mainstays of the *Advanced Saturn* and *Nova* boosters.

NASA estimates the total cost of development of the big engines at $200 million for the F-1 and $150 million for the J-2.

Three other companies—Aerojet-General Corp., Collins Radio Co. and Minneapolis-Honeywell Regulator Co.—have aggregate awards of about $220 million, and are just beginning their subsystems procurement and selection of subcontractors.

Aerojet has a $130-million potential in its M-1 million-lb.-thrust liquid oxygen-hydrogen engine—slated for the *Nova* second stage. In addition, the firm has the $12-million propulsion system contract for the *Apollo* spacecraft's service module. Aerojet procurement on these awards will begin in the near future.

A breakdown of these and other subcontracts:

• **Rocketdyne**—Propulsive booster power for the *Advanced Saturn*, the drop-kick from Earth for the *Apollo* spacecraft, will be supplied by a series of Rocketdyne engines.

The North American Aviation division is responsible for the F-1 and J-2 engines—planned as the booster and upper stage propulsive units for the *Advanced Saturn*.

The big engine complex is made up of five F-1 engines generating a total of 7.5 million lbs. thrust in the first segment *(S-IB)* of the three-stage vehicle. The second stage *(S-II)* will be powered by five J-2 engines producing a million lbs. thrust at altitude.

A single J-2 constitutes the third *(S-IV)* stage, with 200,000 lbs. thrust at altitude. Present planning calls for the current *Saturn* to launch the empty spacecraft and also the manned spacecraft on training missions.

Rocketdyne has a senior technical man serving as program manager and reporting directly to the vice-president and general manager of the liquid rocket division in both the F-1 and J-2 programs. Both programs have representatives from major functional activities—such as management, purchasing, quality control and engineering—to make up the total program management staff.

Design and development activities are carried out by functional units, so the management technique provides direct-line communications and retains the ability to focus a wide variety of skills on any problems that might appear.

There are some unique management aspects: both engine projects use design review boards to build a high degree of reliability and performance into the designs before fabrication.

The boards use computer analysis and a technique best identified as statistical test design and analysis to work out the most complete test program in the shortest possible time. Both programs have employed data processing techniques extensively—for status reports, R&D hardware, production status, parts listing etc.

• **Aerojet**—Besides the *Nova* M-1 engine, Aerojet is involved with the *Apollo* spacecraft itself. The General Tire subsidiary received a $12-million subcontract from NAA to build the service module propulsion engine. The liquid-fueled engine will be used for mid-course corrections and other power requirements.

Fabrication and development testing will be done at the Aerojet facility in Azusa, Calif. Pre-flight rating tests and demonstration firings with flight-type propellant tanks will be performed at the firm's Sacramento facility.

Extensive use of the federal high-altitude test equipment at Tullahoma, Tenn., is also a planned part of the program.

All aspects of the *Apollo* program at Aerojet are under the control of John S. Robbins, in the firm's Space Propulsion Division at Azusa. All necessary facilities are available, and no new ones are planned. Since the contract calls for production of a basic Aerojet product—rocket engines—it is anticipated that less than 20% of the work will be subcontracted.

• **Avco**—The re-entry phase being handled by the Advanced Research and Development Division of Avco Corp. is under a strong technical and administrative program office, which directs and monitors functions relating to all company activities in the *Apollo* program.

Technical capability to cope with associated problems is planned into the overall scheme so that disturbances to the scheduled activities will be kept to a minimum—or entirely eliminated.

The *Apollo* group at Avco is under the direction of Dr. C. F. Berninger.

The line of authority from NASA is via North American directly to Berninger. The subcontracted portions of Avco's program will consist of raw materials and minor items of primary interest to small business firms.

The Avco division maintains an open-door policy in purchasing; any firm with something of use can bid on Avco's programs. Since virtually everything purchased will be in the nature of special orders, there will be different buyers for different specialties—making it impossible for the Wilmington, Mass., division to name, in advance, specific individuals to be contacted.

There is an active small business program at Avco, and more than 80% of the subcontracting on previous space programs have gone to small business firms. Since the *Apollo* contract concerns the same basic problems as the companies past efforts in re-entry nosecones, it is expected that the same proportion will prevail.

• **Marquardt rockets**—Reaction control rocket engines for two of the three *Apollo* spacecraft modules will be built by the Marquardt Corp. under sub-

(Continued on page 75)



IN JUST UNDER SIX MINUTES, UTC PROVED THAT SEGMENTED SOLID PROPELLANT MULTIMEGAPOUND ROCKET MOTORS ARE NOW STATE-OF-THE-ART

January, 1960: UTC fires the first segmented solid propellant rocket motor, under company-sponsored research program. Motor develops 1,100 pounds of thrust. Burning time: **7 SECONDS.** December, 1960: UTC test-fires flight-weight, segmented, solid propellant rocket motor. Three-segment motor develops thrust of 15,000 pounds from high-energy solid fuel developed at UTC. Burning time: **60 SECONDS.** January, 1961: UTC fires second 15,000-pound thrust solid propellant rocket motor. Burning time: **60 SECONDS.** February, 1961: Third straight successful firing of flight-weight, segmented rocket engine is announced by UTC. Burning time: **60 SECONDS.** August, 1961: UTC fires nation's first booster-size, segmented, solid propellant rocket motor for NASA. Motor develops 250,000 pounds of thrust. Burning time: **80 SECONDS.** December, 1961: United States Air Force flight-weight segmented solid propellant rocket booster motor is successfully test-fired by UTC. Countdown begins at 10:59:50 a.m. There are no holds. The motor is fired at 11:00:00 a.m., the precise time set months earlier. The giant motor produces nearly half a million pounds of thrust. All objectives attained, all desired data obtained. (Similar evidence of reliability was demonstrated in all other earlier UTC firings.)

Two years of development and more than 500 sub-scale segmented motor firings of various sizes were climaxed by the 300+ seconds of burning time described above. The tests have proved that solid propellant segmented rocket motors, with multimillion pound thrust levels, can be economically built, assembled under field conditions, and operated with efficiency and reliability.

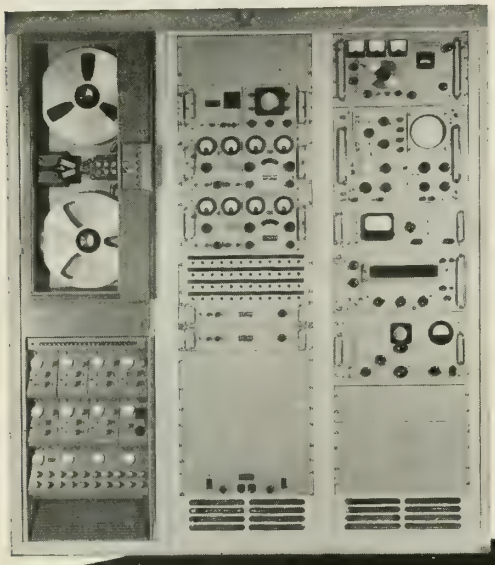
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Technical Problems

(Continued from page 21)

It was found that novolac phenolic resin (substituted carbolic acid), when added to noncharring or slightly charring systems in amounts equivalent to that present in the hexafunctional novolac epoxy (35% by weight), caused the former systems to char. It was also found that the degree of char was approximately equivalent for the three systems.

Another significant factor in the control of char layer behavior has been a variation of the amount of pyrolytic graphite in the ablative char by controlling the chemical structure of the resin system, and using a polymer mixture. The results of Avco's arc ablation tests indicated that a modification of the polymer systems, to obtain an increase in volume of low-molecular-weight hydrocarbons during ablation, resulted in an increase in graphite deposited in the char layer.

Avco researchers found that charring resin systems containing over 50% by weight of silica fibers, when tested under high-heat-flux (1,000-1,500 BTU/ft.^{2}sec.), high-enthaply (150-300 H/RT_o) conditions, form a fused silica skin over the ablating surface which is removed by volatilization and flow. It has been shown that the char layer beneath the ablating surface consists of a series of isothermal interfaces separating successive reaction zones. The ablation behavior of these systems containing high concentrations of silica and other ceramic reinforcements appears to be controlled primarily by surface vaporization or melting of the inorganic component.

Pyrolytic graphite and silicon carbide have not been detected in highly siliceous materials. Also, when low-melting reinforcements such as glass fibers are employed, rapid melting away of the surface causes poor ablative performance. But the use of high-temperature reinforcements may not be necessary or desirable in high-resin-content systems. Since the fiber is coated with graphite, it may be possible for it to melt within this graphite shell and chemically react with the graphite without flowing away. The use of lower-melting fibers may also result in increased depth of melting beneath the ablated surface, allowing more opportunity for complete chemical reaction.

The suitability of lower-melting fibers has been demonstrated by substituting glass for silica fibers. Although this char layer has not been thoroughly evaluated, it has been shown to be one of the hardest, most dense chars obtained in the program.

The ability of a polymer to form

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and retain a stable char during ablation is affected by chemical and mechanical erosion of the surface. Char may be removed from the surface by any of several competing mechanisms:

- —Oxidation
- —Vaporization
- —Surface erosion
- —Failure of the char beneath the surface

The first three mechanisms are primarily confined to the surface. Vaporization and oxidation may, however, occur beneath the surface if the char contains a volatile material or an oxide (e.g. silica) which can be reduced by the surrounding carbon. The rate of oxidation of the carbon at the outer char surface may be determined by the rate of diffusion of oxygen into the surface through the boundary layer.

Erosion may occur at the surface if the surface char is weak (for example, due to the melting and/or vaporization of supporting silica fibers), if inhomogenetics cause the char surface to be irregular with projections into the gas stream, or if the combination of surface and thermal stress is greater at the surface than below the surface. ⁂

TELECOMMUNICATIONS

COLLINS RADIO CO. will supply the telecommunications system for the three-man *Apollo* spacecraft to be constructed by North American's Space and Information Systems Division.

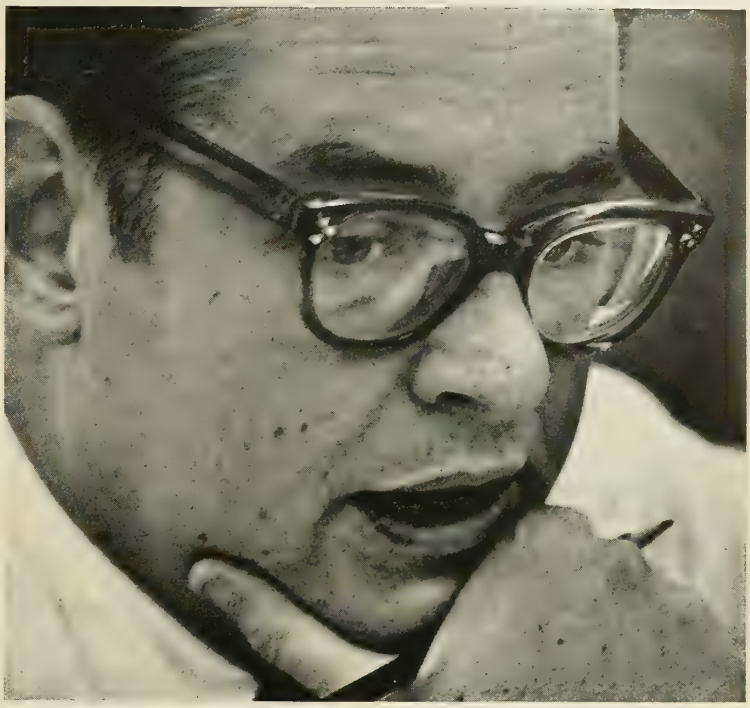
Under the terms of its $4-million contract, Collins' plans for the spacecraft's telecommunication system tentatively include the following major functions and characteristics.

• **Voice transmission and reception**—During the entire course of the flight mission it will be necessary for the astronauts and ground personnel to talk to each other. Redundant equipment in the form of dual command transceivers will be provided to give reliable voice communications in both orbital and rescue operations. Frequency used will be in the P band.

• **Intercommunications** — A four-position spacecraft intercommunications system will enable the astronauts to converse with each other within the spacecraft either while in their G couches or while moving around the confines of the craft.

• **Television** — A complete closed circuit television system will be provided to act as a visual link between the capsule and operational control stations on earth, this will enable observation of the reactions of the astronauts during lift off and flight and later will be used to observe the topography of

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Engineers familiar with programming, operations, and instrumentation for ballistic missile flight test.

Reliability Engineers to assess the reliability and to optimize the configurations and mission profiles of space systems.

Chemical Engineers to work on the development and applications of structural adhesives for aerospace vehicles.

Metallurgical Engineers for research and development on materials and joining.

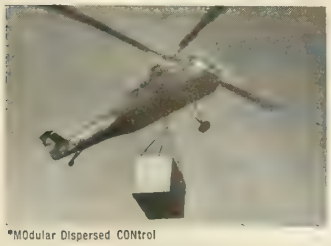
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SPACE AND INFORMATION SYSTEMS DIVISION
North American Aviation

the moon. This system could also be used to monitor the various instruments on the control panel in case of an in-flight emergency. Provision will also be made for a television receiver aboard the spacecraft as part of a closed loop circuit to enable the space crew to view external and remote sections of the spacecraft during flight.

• **Telemetry equipment** — Two P-band FM telemetry transmitters on board will enable the transmission of biomedical, scientific and operational information back to Earth.

• **Tracking and ranging**—To keep the earth tracking stations fully informed of the spacecraft's exact position, C-band tracking and ranging equipment will be included. Earth stations may in turn transmit information to the space crew, supplementing DTA provided by on-board navigational systems.

• **Rescue voice and beacon**—This equipment will be included in the system primarily for use during the landing phase of the mission or could find use during an in-flight emergency situation if necessary.

Two rescue beacons, operating on the HF international distress frequency will provide the capsule's bearing during retrieval operations. One of these will be an SSB transceiver while the other will be in the VHF range and will, as on Project *Mercury*, use the pulsed "Sarah" principal .

• **Storage** — On-board storage facilities will be provided for those periods when direct communications with the Earth will not be possible because of the location of the Earth-based communications facilities and during the periods when the spacecraft is behind the moon. Two recording systems will be on board: one will store information from the analog data sensors and voice communications while the other will store digital data from the PCM data system.

• **NASA R&D transmitter** — Also included in the on-board communications equipment will be a small experimental transmitter that will be constructed with NASA's direction. Details of this piece of equipment are not firm as yet.

• **Multiplexers** — The system includes two antenna multiplexers, a main multiplexer tieing to short range antennas and a diplexed tieing to DSIF antennas. Main multiplexer inputs are from the rescue transmitters and beacons, command transmitters/receivers, telemetry transmitters and the NASA R&D transmitter. The diplexer receives its signal from a pair of redundant power amplifiers that receive inputs from a pair of DSIF transponders feeding from the control panel. Automatic changeover switches are provided in case of an inflight emergency to increase system reliability.

• **Antennas**—The complete *Apollo* telecommunications system calls for 10 antennas. A high frequency whip antenna similar to one used for *Mercury* will be provided for the SSB transceiver used during the rescue phase of the mission. The main multiplexer by way of a VHF antenna changeover switch will output to either the main antenna or a rescue antenna.

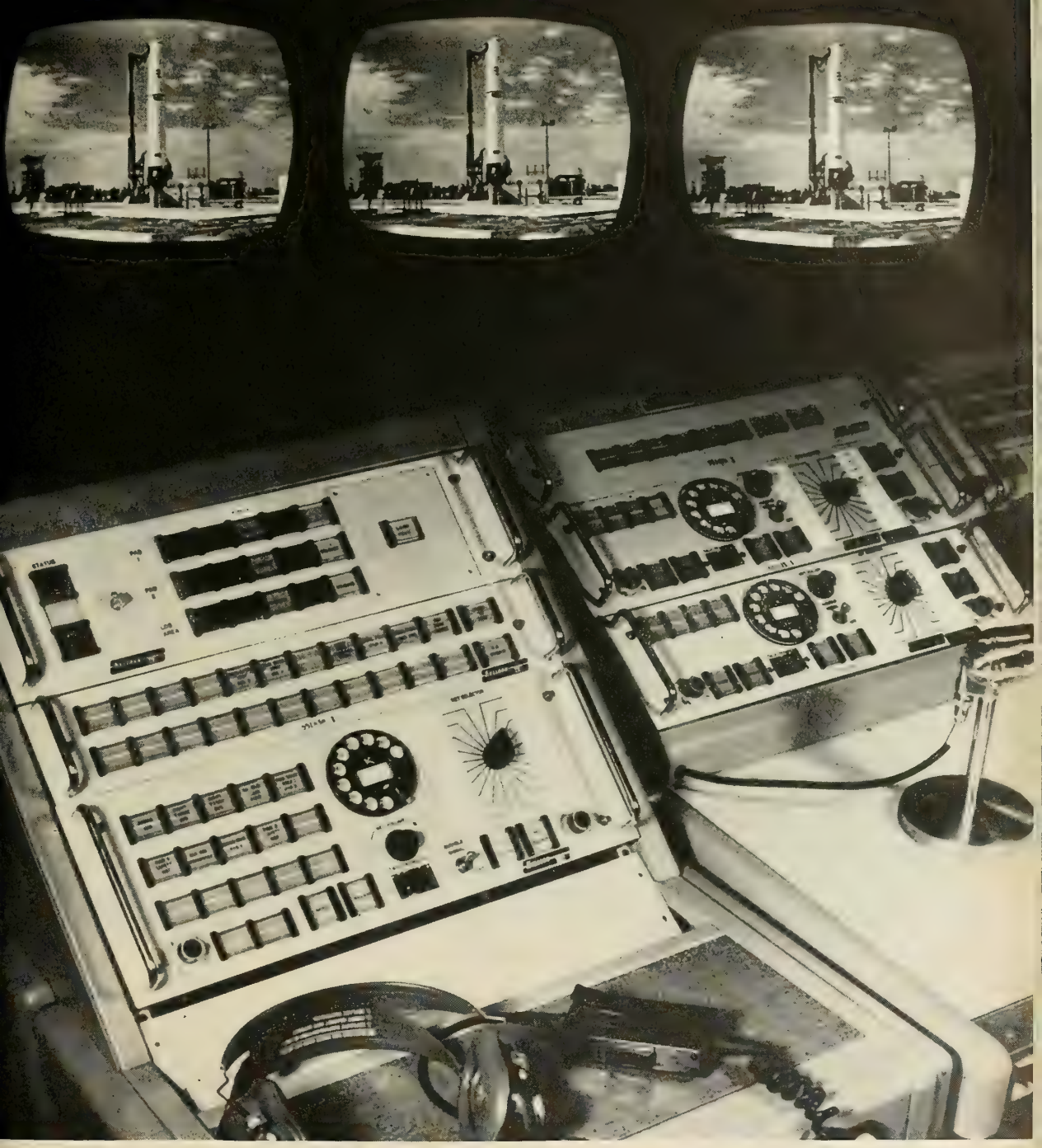
The main antenna will be a discone consisting of two separate portions of the capsule cone with their junction making the discone. This will allow simultaneous reception and/or transmission of information. The main antenna will find use during launch, Earth orbit, deep space, moon orbit, return and rescue phases of the mission. The rescue antenna will be deployed on

The Apollo Team

Center	Responsibility	Chief Procurement Officer
NASA Headquarters	*Overall Management Responsibility*	*Ernest W. Brackett*
Manned Spacecraft Center	*Spacecraft*	*David W. Lang*
Marshall Space Flight Center	*Launch Vehicles*	*W. A. Davis*
Launch Operations Center	*Mission launches & Support*	*Gerard Michaud*

Launch Vehicles

Vehicle	Contractor	Amount
Saturn C-1		
S-1 Stage	*Chrysler Corp.*	
S-IV Stage	*Douglas Aircraft Corp.*	
Advanced Saturn		
S-1B Stage	*Boeing Co.*	*$500 million*
S-II Stage	*North American Aviation, Inc.*	*$300 million*
S-IVB	*Douglas Aircraft Corp.*	*$200 million*
Engines		
H-1 (Saturn C-1)	*Rocketdyne Div., NAA*	
F-1 (Adv. Saturn, Nova)	*Rocketdyne Div., NAA*	*$200 million*
J-2 (Adv. Saturn, Nova)	*Rocketdyne Div., NAA*	*$150 million*
M-1 Nova	*Aerojet-General Corp.*	*$130 million*
RL10A3 (Saturn C-1) (Centaur)	*Pratt & Whitney Aircraft*	



countdown means communications . . .

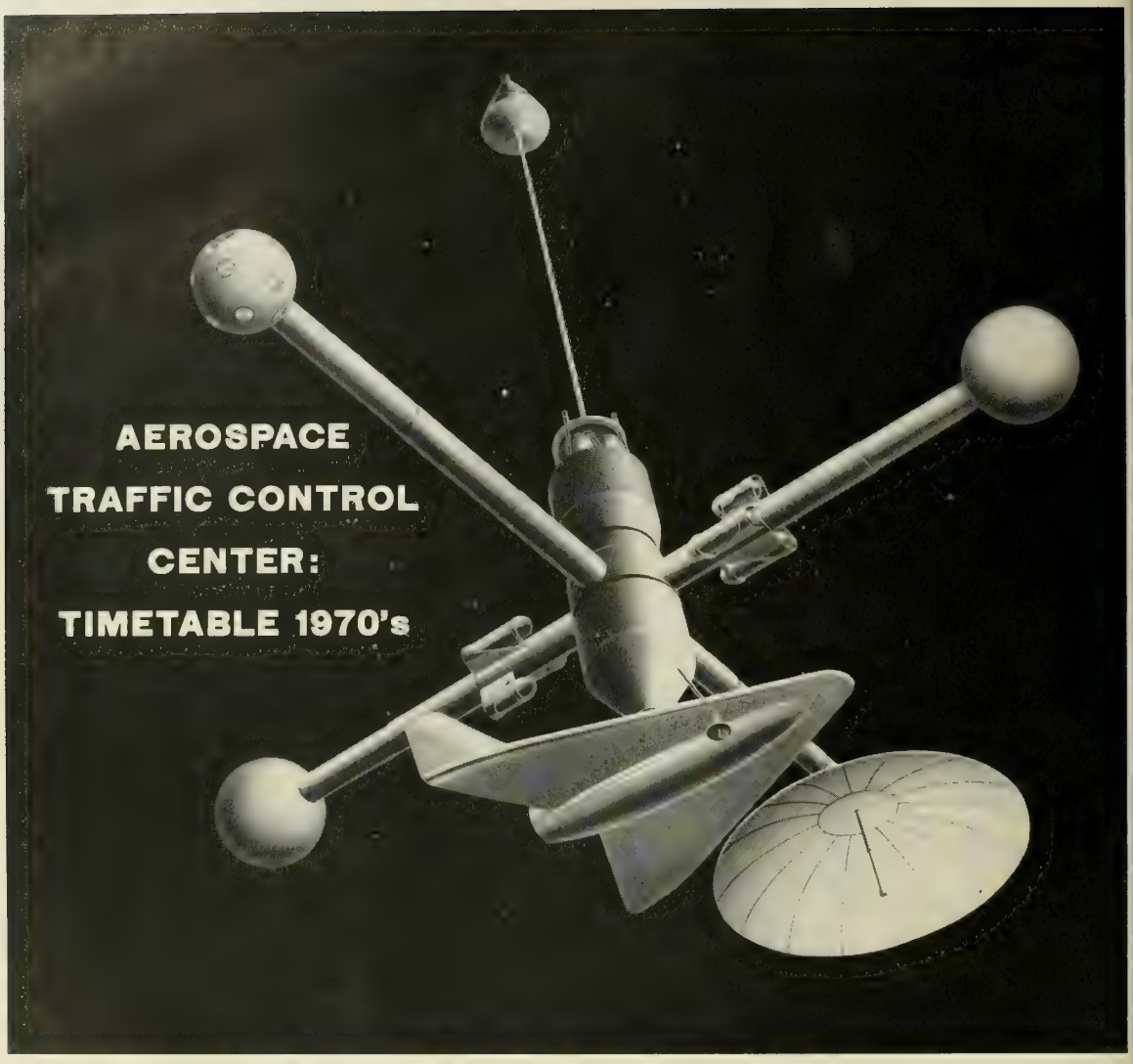
ITT Kellogg has designed, installed and maintained the ultra reliable and sophisticated communications equipment that ties the incredibly complex countdown and launch operation of Vandenberg A.F.B. into an orderly, fail-safe, functioning system for Atlas, Titan, Thor and Minuteman. Countless combinations of technicians, scientists and specialists are in constant contact, both individually and in multi-person conferences, without confusion or interruption. Tape-recorders automatically monitor critical calls. Ingenious "back-up" facilities make communications breakdown impossible. From countdown, through launch, to sending the all-important pulse that alerts downrange stations that the bird is on its way, ITT Kellogg communications are the ultimate in reliability.

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- Is prime contractor for Atlas communications
- Furnishes complete ground communications for several Titan and Thor (Discoverer) sites

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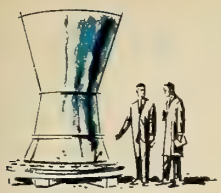
The station—aeroscope traffic control center of the 1970's—will be assembled in orbit in a series of pieces brought together by rendezvous techniques. Included: Command center; living quarters; maintenance station; radar and infrared sensing devices; nuclear power supply; communication links with the earth and other space vehicles. As now planned, 12 people will man the vehicle. Their tour of duty will be measured in weeks.

For four years Lockheed-California Spacecraft has concentrated on the needs of man in space. Activities embrace all fields pertaining to development of complex spacecraft as well as supporting technologies. An operation of such magnitude opens many doors of opportunity.

Scientists and Engineers of outstanding talent and training are needed to develop new Spacecraft, Aircraft, ASW concepts in: Human Factors; Physics (theoretical, plasma, high-energy, solid state, infrared, optics, nuclear); Thermodynamics; Servosystems; Reliability; Guidance and Control; Dynamics; Electronic Systems; Aerospace Ground Equipment; Bioastronautics; Systems Integration and Trade-Off; Space Mechanics; Sub-Systems Synthesis and Analysis; Nuclear, Electric and Liquid Rocket Propulsion; Electronics Research; Hydrodynamics. Send résumé to: Mr. E. W. Des Lauriers, Manager Professional Placement Staff, Dept. 1705, 2404 N. Hollywood Way, Burbank, California. An equal opportunity employer.

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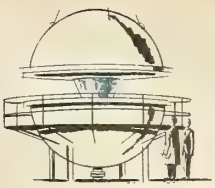
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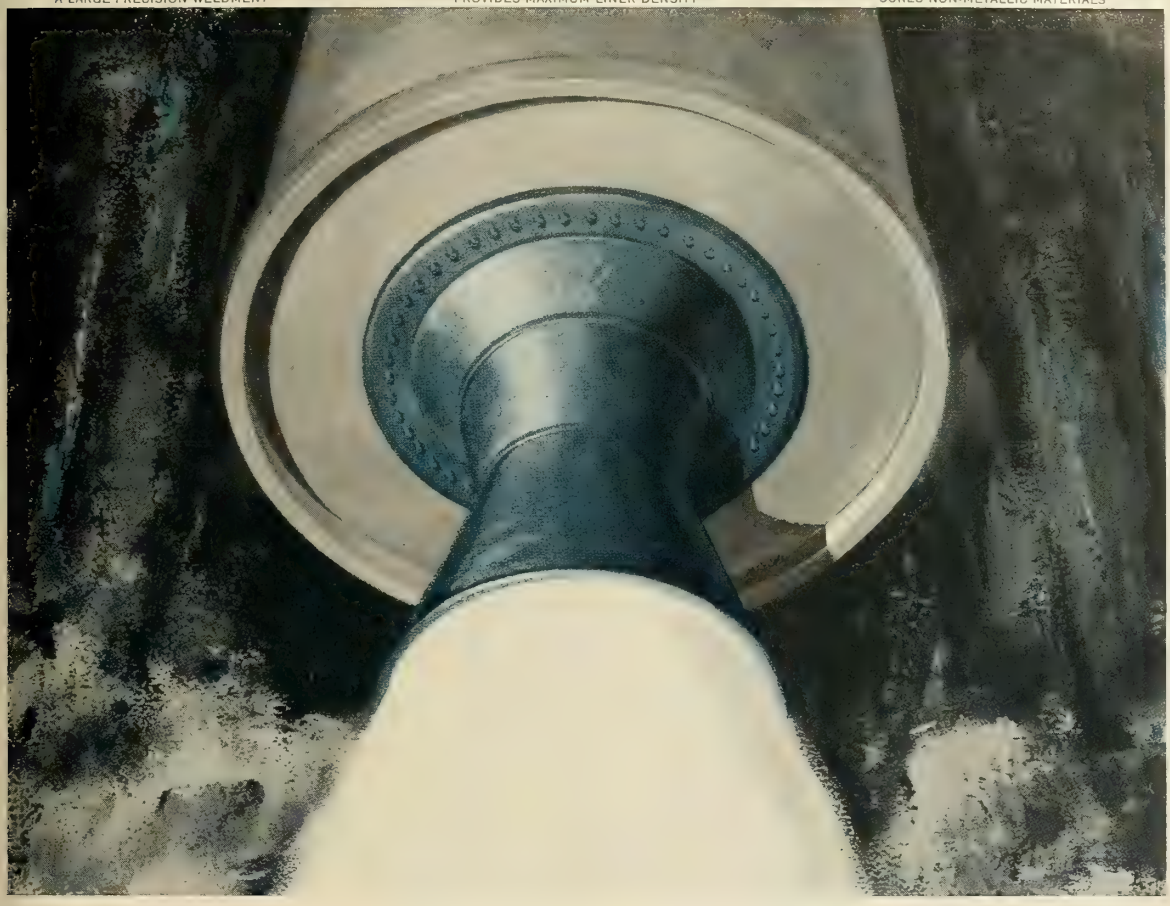
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para-release automatically during reentry.

The C-band transponder will call for four C-band antennas and associated power dividers that will be supplied by NAA and will be used for the ranging and tracking phases of the mission.

In deep-space operation two parabolic antennas will be used, a radar parabola and a DSIF parabola. DSIF selector switch will be provided to change transmission over to a third DSIF omni-antenna when necessary.

• **Integrated modular concept**—For maximum communications reliability during the moon flights, the spacecraft telecommunications system will be designed on an "integrated modular" (IM) concept and will have all of the vital modules in duplicate as spares.

Size can be varied in uniform increments to handle systems of varying complexity in much the same fashion as ATR units are used in integrating communication systems of airplanes. In space use, the terminology SEP (Space Electronics Package) might be applied to a standard unit of size.

As an example of the capability in size reduction of the IM concept, Collins suggests that implementation to the present *Mercury* communication equipment would present a reduction in size of more than 20 percent with an equally significant reduction in weight.

Realizing that a communications electronics failure in a manned capsule would jeopardize both the capsule occupants and the mission performance, Collins has formed an *Apollo* telecommunications reliability team to insure that no aspect of the comprehensive space flight reliability program is overlooked.

As in the *Mercury* program, the nature of the *Apollo* capsule will present many design problems. Special care will be necessary in the design of all electronic equipment to enable safe operation in the capsule atmosphere without the liberation of toxic gases in sufficient quantity to harm the astronauts. All switch and relay contacts must be carefully sealed to avoid any sparking since sparking liberates ozone, which can be toxic in sufficient quantities.

• **System power requirements**—Aided by the use of the integrated module concept, the total power consumption of the telecommunication system will be kept low. Transistors and semiconductor devices will be used wherever possibe. Vacuum tubes will be used only in those areas where the power level precludes use of transistors or in higher frequency ranges where transistors are not yet applicable.

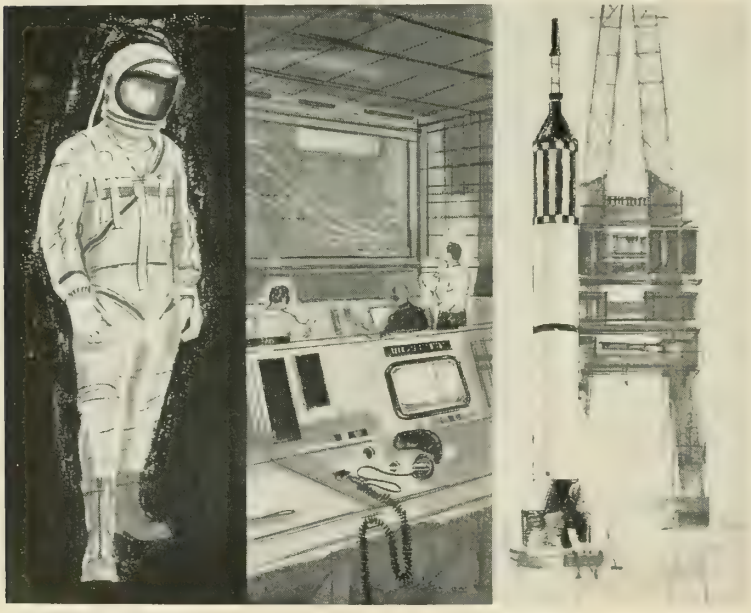
• **Test and checkout**—Due to the complexity of the telecom systems specially designed system test and checkout equipment, a specially designed system test area will be fabricated. FIB 2 /Query/ show the test area layout. Such a complex will be available at Collins radio during telecom system construction and preliminary checkout and a similar complex will be available at the launch site. Individual benches will be provided for unit test.

• **Environmental performance**—As in any space mission, environmental performance of the electronics on board the *Apollo* craft will be essential toward mission success. Each flight phase of the program will have greatly differing requirements. Vibration, shock and acoustic noise will be of paramount importance during the launch phase, while temperature and pressure become increasingly important during the flight and re-entry phases. Shock will again become a problem in the landing phase.

The most serious factors will be vibration and temperature; these will be solved by foam incapsulation and by heat sinks and liquid cooling systems. Studies are being conducted to find methods best suited toward eliminating or reducing to accepted limits all of these problems. ⌗

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SPACECRAFT

PRESENT NASA PLANS call for building 18 Earth-orbiting *Apollo* spacecraft—12 for development units and the remainder for operational and flight units.

All versions of the spacecraft, except the lunar-landing type, are made up of two modules—the command module and the service module. Equipment within these modules is switched and replaced to accommodate specific missions such as circumlunar or lunar orbit.

The lunar-landing mission requires a third module in order to carry the lunar-landing propulsion.

• **Specifications** — Weighing about 75 tons and nearly 90 ft. in length, the three-module spacecraft will have a cone-shaped nose—the command module—and cylindrical second and third modules.

Housing the three astronauts, the command module is expected to weigh between four and five tons, be 15 ft. long, and have a 13-ft.-dia. base. Immediately behind the command module is the service module, which will contain external stores—equipment either not needed for re-entry or not adaptable for in-flight maintenance by the crew.

Major item in the 20-ton, 15-ft.-long service module will be the abort and space propulsion system. This is an Earth-storable, hypergolic-propellant type system with a thrust level of approximately 20,000 lbs.

Behind the service module will be the lunar-landing module which decelerates the command-service modules to the lunar surface and brings them in for a soft landing. For this mission, hydrogen-oxygen propellants will furnish a throttleable thrust of some 60,000 to 100,000 lbs. The fully equipped module is expected to weigh about 50 tons and be about 60 ft. long.

Aerodynamic control of the command module will be through a fixed center of gravity offset with path control by roll-modulation only. This means that the module will be self-trimming; in addition, it will have reaction jets to furnish small turning moments when they are needed.

These reaction jets will probably use the same type of propellants as the service module—typically, a mixture of N_2O_4 and hydrazine.

All the modules are likely to be built with structure and honeycomb made of stainless steel and aluminum. In addition, the command module will be given re-entry thermal protection by ablation.

Power for the *Apollo* spacecraft will be furnished by Pratt & Whitney Aircraft Div. fuel cells producing an aver-

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The abort system used by the *Apollo* astronauts will be similar but somewhat more complicated than the one used in the *Mercury* project.

All major subsystems for *Apollo* astronauts will be similar but somewhat more complicated than the one used in the *Mercury* project.

All major subsystems for *Apollo* have been contracted for. North American will make the spacecraft shells and integrate the equipment. ⌗

SPACE MEDICINE

THE TWO MAJOR technical problems facing Project *Apollo* in the aerospace medicine area are prolonged weightlessness and radiation hazards for the three-man spacecraft's astronauts.

To meet them, the Kennedy Administration has established a joint NASA-Air Force-Navy-Atomic Energy Commission.

About 35% of NASA's space medicine work is being done by the Defense Department, and experts expect this trend to continue. Decisions on what portion of the work DOD should do, and under what terms, are made by the new Joint DOD-NASA Bioastronautics Planning Group headed by Brig. Gen. Charles H. Roadman, director of NASA's Office of Aerospace Medicine, and Col. John M. Talbot of DOD. The planning group has a pool of about 50 technical experts upon which it can call for advice in specialities. The joint group was set up in February of this year.

The Naval School of Aviation Medicine has been charged with the research on disorientation, acclerations and weightlessness. The Navy is getting a new slow rotation room (M/R, March 26) to study vestibular function and is initiating a number of animal studies to determine the exact functions of the various portions of the inner ear.

Vibration and impact tolerance studies will be carried out by the Air Force at the Aerospace Medical Laboratory at Wright-Patterson AFB. Radiation studies will be handled almost solely by the Atomic Energy Commission, presumably giving parts of it to universities and other groups. The Air Force will have the only other piece in the radiation program in support of its biological effects studies in the Radiobiological laboratory at the School of Aerospace Medicine.

Gen. Roadman cites the radiation

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nformation problem as "critical" since hielding data for *Apollo* must be btained by the end of 1963.

NASA's aerospace medicine offiials do not foresee going to a recycled vater supply system or elaborate regenerative oxygen system such as lgae. They say that *Apollo* requirements are well within the state-of-the-rt and the lead time so short that laborate research on new methods is ot feasible. All basic research in life ciences is done at Ames Research Center, in the Office of Space Sciences.

Toxicity studies and development f lightweight methods of removing hese contaminants is programed. Cabin atmospheric monitoring systems vill also be developed.

Award of a pressure suit contract s expected imminently. Management f this part of the program is in-house, vith contracting done with industry or the product.

NASA will need development of ther flight garments, development of riteria for tools to be used in mainenance and repair in space, developments of survival equipment and post anding recovery aids.

• **Animal experiments** — Roadman old M/R that NASA plans no elaborate animal studies to prepare for putting man in orbit for prolonged periods. He struck a strong blow at animal research advocaters by saying that "We ust can't take time for a long animal esearch program. We're in the manned paceflight business right now. Unless t looks very hazardous or prejudicial o man, we're going to go ahead and ake the manned route."

However, a number of animal experiments are now being prepared vhich will be flown with men aboard n the orbiting laboratory. As Roadman puts it "There is no proven 1-1 atio of animals and men. We need uman observers on board and we nust have a man on board to assure n-station capability. Then we can leep-instrument the animal and study he man at the same time—in the pace environment. ⁂

Budget and Plans

(Continued from page 17)

ions Center at Cape Canaveral responible for the procurement of launch complex equipment.

NASA will continue to rely almost exclusively on the cost-plus-fixed-fee contract. The one major switch in its contracting procedures has been the establishment of a space agency management group at the North American plant at Downey, Calif. Similar groups will be set up to monitor NASA contracts at other contractor plants. ⁂

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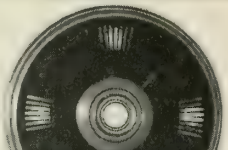


Photo shows DRC OPTISYN with one ruled disk removed. Four extended-area light sources shine through the fixed grating. When the movable grating is in place, a unique and bright moire interference pattern is created for incremental shaft-angle readout.

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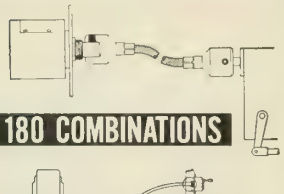
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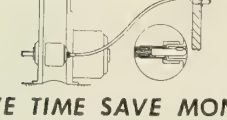
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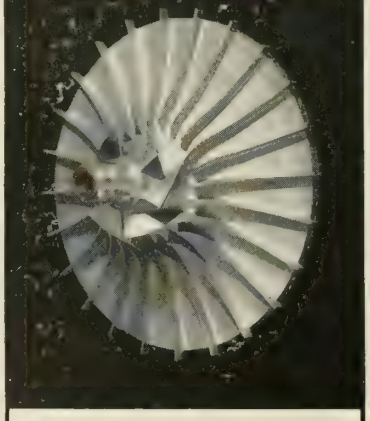
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Boeing Builds S-1C's

(Continued from page 55)

group will purchase and control capita equipment, maintenance, repair and op erating supplies for Michoud's *S-1C* program. Excluded are items procure by the Michoud "housekeeping" con tractor.

Support for the three organization above will come from Materiel Prograr Planning and Control, Price Redeter mination and Cost Analysis, and Traffi Control.

—*Program Planning and Control*— Responsible for office systems of th Material Dept., plus office service change coordination, program plannin and control, and coordination of repor ing requirements, Another function wi be coordination with the Material Dep in support of the PERT program.

—*Price Redetermination and Co Analysis* — Responsible for negotiatio of all price redetermination purchase preparation of prime contract pricin estimates, value analyses, and subcor tract pricing assistance.

—*Traffic Control*—Responsible fc all activities of the Saturn Booste Branch concerning materials movemen to and from Michoud, and for assis ance to the Booster Test Dept. in tran porting *S-1C* stages.

The Reliability and LOX Contan ination Asst. will coordinate procur ment and supplier efforts for approv of subcontractor quality control sy tems, subcontractor acceptance testir and reliability standards.

MSFC and AMR Support offic personnel will locate at Huntsville ar AHR to perform Materiel services fc Boeing Saturn operations at those site

• **Picking sources**—Boeing has r one method for a source selection, b will run the gamut of accepted metho as required by the specific procuremer

Primary source consideration is a intial bidders list compiled from suc factors as a known capability, achiev ments in related fields, presentation past experience, with Boeing, and i quiries from industry.

Final bidders selection will ste from Materiel's review of the list firms.

In some cases, Materiel Dept. repr sentatives will make a personal surv of a prospective bidder's facilities, it may ask a "new" firm on the bidde list to make an extensive and detail presentation of the firm's capabilities.

Bidders qualified for a possible pu chase order will be sent a Request f Proposal with an invitation to bid, da of bidders conference and proposal ceipt deadline.

If necessary, an Evaluation Boa will be set up by Materiel to study pr

oposals. The board will consist of representatives from Engineering, Facilities, Finance, Quality and Reliability Assurance, Materiel and Manufacturing Depts. It will be headed by the Materiel representative.

A bidders conference or evaluation board will not be required in all procurement cases. Oral presentations also will be asked only in specific cases. A formal survey of prospective suppliers is required, however, for purchases of complex equipment or those with long-term production requirements.

All unsuccessful bidders, when possible, will attend a debriefing to point out deficiencies in their proposals. Boeing believes it will receive a better proposal the next time as a result. ⌗

Other Contractors

(Continued from page 58)

ontract from NAA. The engines will e used in the command and service nodules and are components of the ight stabilization and control system eing developed by Minneapolis-Honeyvell. The contract amount is still under egotiation.

• **Collins Radio**—Telecommunications system supplier for *Apollo* is Collins Radio Co., under a $40-million NASA contract. Major systems include:

—Voice communications (P-band): Dual command transceivers, for redundancy, to increase reliability in both escue and orbital missions.

—Intercommunications: A four-position intercom system capable of use n all design g-environments.

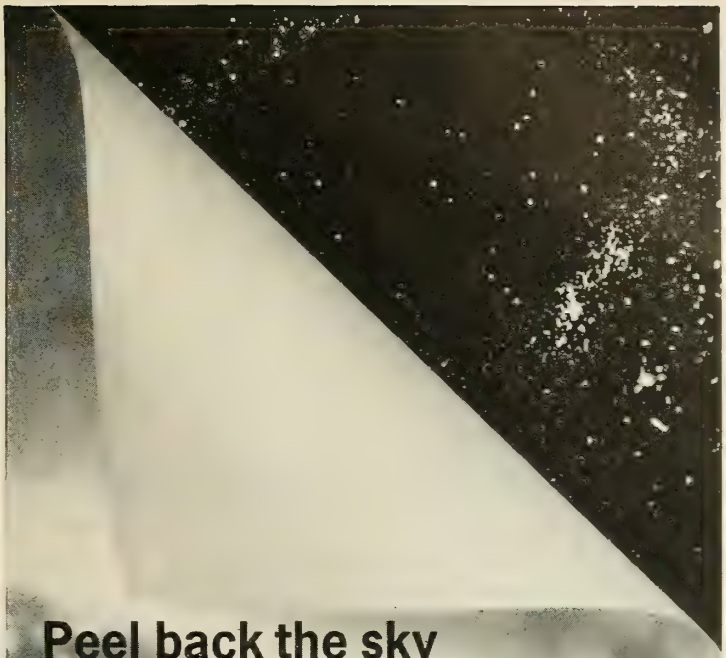
—Television: Closed-circuit TV for nking the capsule to Earth, for lunar bservations from the capsule, and for emote *Apollo* subsystem monitoring.

—Other: FM P-band telemetry ransmitters (2), C-band tracking and anging equipment, HF distress beacons, data storage recorders for delayed eadout, an R&D transmitter, a dual ntenna multiplexing system, and test nd checkout.

• **Minneapolis-Honeywell**—Stabilization and electronic flight controls for he *Apollo* craft will be supplied under a $30-million-plus NAA subcontract to Minneapolis-Honeywell.

The Honeywell group under director O. A. Thornsjo will employ a PERT-type system to handle the development and production of the stabilization and flight control system, cockpit display panel, manual controls, support equipment and flight systems ntegration.

In a unique move, the firm will have wo checkout engineers follow the system right to the launch pad—to reduce omplexity and duplication. ⌗



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IBM Space Guidance Center

IBM engineers and scientists are helping to map the heavens by developing a digital data processor and memory for the NASA Orbiting Astronomical Observatory (OAO).

The memory, largest of its type for space application, will collect observations free of the earth's atmospheric distortion. As the vehicle orbits at 18,000 miles/hr., the data processor will tell the OAO's sensitive telescope where and when to look, check for occulted and malfunctioning star trackers, start and stop each experiment. Over 200,000 bits of information, stored in the satellite's random-access memory, can be telemetered to the ground in 7.5 seconds. In designing the memory and processor, a redundancy technique provided a system far more reliable than conventional designs.

Other projects include: guidance and control systems for manned aircraft, satellites, spacecraft, submarines, and other vehicles. Engineers and scientists are invited to inquire about openings in . . . reliability statistics; logic design; circuit design; programming; quality engineering; control systems engineering; solid-state physics (radiation effects studies); mechanical engineering (heat transfer/stress analysis).

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John N. Phillips: Elected general manager of United Aircraft Corp.'s Norden division in Norwalk, Conn.

Allen M. Bower: Appointed vice president of the newly formed Defense Division of Fluid Controls, Inc., Mentor, Ohio.

Charles T. Blake: Elected vice president-engineering of the Warner & Swasey Co., Cleveland. **Prosper E. Schaffer** elected vice president-manufacturing.

E. Swain Russey: Elected group vice president of Borg-Warner Corp., Chicago. **Alonzo B. Kight** elected a vice president.

Thorlief Knutrud: Appointed engineering specialist at the Applied Research Laboratory of Sylvania Electric Products, Inc., Needham, Mass.

John S. Gordon: Appointed manager of proposals by Astrosystems International, Livingston, N. J.

Edward C. Gustely: Quality control administrator at Aerojet-General Corp., Sacramento, awarded an Alfred P. Sloan Fellowship in executive development at MIT.

John M. Wright: Appointed information assistant in the Office of Information of the AEC's Nevada operations office in Las Vegas.

William G. Christmas: Appointed divisional vice president and *Titan* project director of American Machine & Foundry Co.'s Government Products Group, Littleton, Colo.

Major Gen. John A. Barclay (ret. deputy commander of the Army Ordnance Missile Command at Redstone Arsenal): Elected to serve on Board of Directors of Astrosystems International, Livingston, N. J.

Ralph T. Osborn: Elected a vice president of Lockheed Aircraft Corp. He will continue as president of the Lockheed Aircraft Service in Ontario, Calif.

Dr. Alfred N. Goldsmith: Noted scientist, engineer and inventor, elected an honorary vice president of RCA.

Maurice Roy: Professor of mechanics at École Polytechnique (Paris) and member of the French Academy of Sciences, elected president of the Committee on Space Research (COSPAR).

Frank Gard Jameson: Named vice president-planning for aircraft division of Douglas Aircraft Co. He was president of Pacific Automation Products.

William B. Reike: Elected executive vice president of Lockheed Aircraft International, Inc. He was vice president.

Earl D. Hilburn: Formerly president and director of Burtek, Inc., elected vice president and general manager of Curtiss-Wright Corp.'s electronics division. **George R. Leonard,** former corporate general sales manager at Twin Coach Co., named general sales manager of metals processing division.

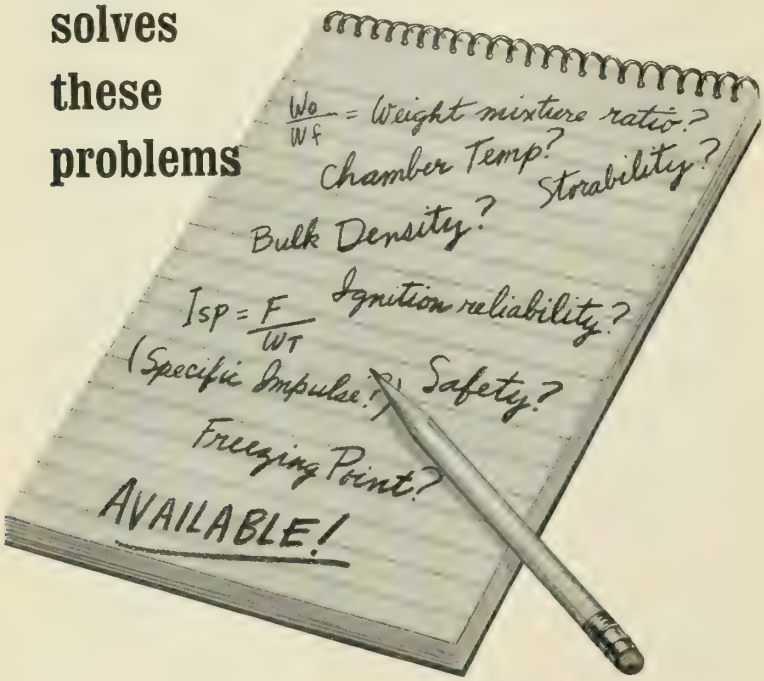
William C. West, Jr.: Elected vice president and manager of Gulton Industries Inc.'s general industrial group. He was formerly president of West Instrument Corp., a subsidiary.

George M. Ryan: Elected president of Benson-Lehner Corp., Los Angeles. **Bernard S. Benson,** founder of the company advances to chairman of the board.

Lt. Gen. William D. Eckert (USAF Ret.): Joined the staff of Aerospace Industries Association, Washington, D. C.

A. C. Werner, Jr.: Appointed marketing manager of Phillips Control Co., Joliet, Ill., a division of Phillips-Eckhardt Electronic Corp.

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Office of Manned Space Flight

The Office of Manned Space Flight seeks to appoint three highly qualified professional men to Assistant Directorships of its Integration and Checkout Division. The duties inherent in these positions will have a direct and material bearing on the nation's manned space flight programs and require management as well as technical or scientific capability of a high order. Selected applicants will be in a position to build their own technical and supporting staffs.

Assistant Director, Checkout

You will direct the development of manned space vehicle system checkout equipment that will meet overall project requirements. Thus, you will review subsystem checkout design concepts and specifications, insure compatibility of the checkout equipment (being developed by contractors) with system objectives, as well as direct the design and development of an integrated system checkout equipment for Apollo.

The position requires at least a BS in EE and ten years' experience in electronic systems implementation.

Assistant Director, Reliability Assessment

You will assess reliability achieved in the space vehicle system development program, compare the reliability with overall project requirements, and direct a major contractor effort in this area.

Respondents should have at least a BS in EE or Aeronautical Engineering and ten years' broad experience in electronic or aeronautical/missile system reliability program implementation.

Assistant Director, Integration

You will be responsible for the implementation of a program to insure the integration of the Apollo space vehicle equipment development program.

Duties require at least a BS in EE or Aeronautical Engineering and ten years' experience in electronic or aeronautical/missile systems implementation and direction.

Direct your inquiry in confidence to:
Director of Manned Space Flight, Dept. 130
NASA
Washington 25, D.C.

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Dr. Glenn Murphy: Elected president of the American Society for Engineering Education. Dr. Murphy is head of nuclear engineering and Anson Marston Distinguished Professor of Engineering at Iowa State.

Richard M. Wight: Appointed director of communications for IBM, New York.

A. R. Farrell: Appointed advance design director for Northrop Corp., Ventura Division.

Herbert S. Abrams: Appointed manager, component reliability and test department, at the guidance and control systems division of Litton Systems, Woodland Hills, Calif.

Theodore W. Johnson: Senior vice president of Security First National Bank of Los Angeles, elected a board member of the Douglas Aircraft Co.

Robert C. Bitting, Jr.: Manager, *Minuteman* program, of the Radio Corp. of America's Defense Electronics Products, awarded an Alfred P. Sloan Fellowship in Executive Development at MIT.

James N. Ebright: Named assistant secretary and chief counsel of Aerojet-General Corp., Azusa, Calif.

John J. Duggan, Jr.: Named sales manager of Weatherhead Company's aviation and missile products division, Cleveland.

Dr. Frederick J. Milford: Appointed assistant director of technical development at Battelle Memorial Institute, Columbus, Ohio.

Dr. Oliver R. Price: Named chief engineer of Micro-Radionics, Inc., Van Nuys, Calif.

Wen Tsing Chow: Appointed manager-computer products for Arma Division, American Bosch Arma Corp., Garden City, N. Y.

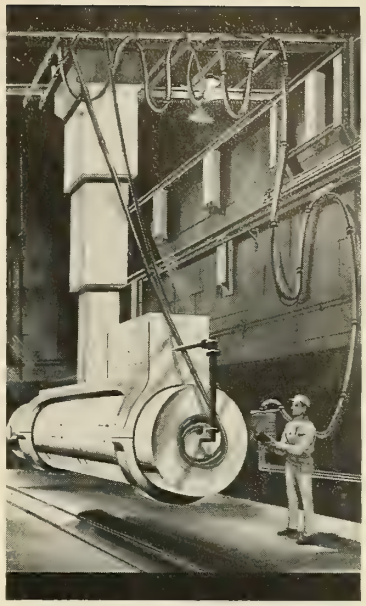
Dr. Solomon L. Miller: Joined the central research staff at Varian Associates, Palo Alto, Calif., as a senior research scientist.

Chesterfield F. Seibert: Appointed president of Trinity Equipment Corp., Cortland, N. Y., a subsidiary of Pall Corp., Glen Cove, N. Y.

Richard M. Mikesell: Appointed field service engineering manager of Electronic Communications, Inc., St. Petersburg, Fla.

A. Waller Howard: Named marketing manager for General Electric's Large Jet Engine Dept., Evendale, N. Y.

Robert Gorrie: Named customer engineer for the space and defense products division of Bausch & Lomb, Inc., Washington, D. C.



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MAY

ASME Hydraulic Conference, Bancroft Hotel, Worcester, Mass., May 21-23.

8th National Aero-Space Instrumentation Symposium, sponsored by the Instrument Society of America, Marriott Motor Hotel, Washington, D.C., May 21-23.

1962 National Telemetering Conference, Sheraton Park Hotel, Washington, D.C., May 21-23.

American Society for Quality Control, Annnual Convention and Exhibit, Netherlands-Hilton Hotel, Cincinnati, May 23-25.

Acoustical Society of America, Hotel New Yorker, New York City, May 23-26.

International Space Aerorama, Miami, May 25-27.

The First Annual Convention of the American Association for Contamination Control, Jack Tar Hotel, San Francisco, May 28-30.

JUNE

Engineers Joint Council, Nuclear Congress and Exhibit, The Coliseum, New York City, June 4-7.

Society of Technical Writers and Publishers, Annual Meeting, Sheraton Hotel, Philadelphia, June 6-8.

Cornell University Seminars in Industrial Engineering Operations Research and Statistics, Ithaca, N.Y., June 12-15.

American Institute of Electrical Engineers, Summer General Meeting and Aero-Space Transportation Meeting, Denver Hilton Hotel, Denver, June 17-22.

American Nuclear Society, Annual Meeting, Statler-Hilton Hotel, Boston, June 18-20.

Institute of the Aerospace Sciences, Annual Meeting, Los Angeles, June 19-22.

American Society for Testing and Materials, Annual Meeting, Statler Hotel, New York City, June 24-29.

Summer Institute in Dynamical Astronomy, Yale University, New Haven, Conn., June 25-August 2.

ASME Aviation and Space Division Annual Conference, University of Maryland, College Park, June 26-28.

JULY

Reliability Training Conference, sponsored by American Society for Quality Control, Princeton Inn, Milwaukee, July 8-15.

American Rocket Society, Lunar Missions Meeting, Pick-Carter and Statler-Hilton Hotels, Cleveland, July 17-19.

AUGUST

Institute of the Aerospace Sciences, Man-Machine Competition, Olympic Hotel, Seattle, Aug. 10-11.

Nuclear Propulsion Conference, sponsored by American Rocket Society, American Nuclear Society and Institute of Aerospace Sciences, U.S. Naval Post-Graduate School, Monterey, Calif., Aug. 15-17.

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—contracts—

AIR FORCE

$24,600,000—**Hughes Aircraft,** Culver City, Calif., for production of *Falcon* missiles and test systems. Work to be done at Tucson, Ariz.

$16,300,000—**General Dynamics Corp.,** San Diego, for work on the *Atlas* intercontinental ballistic missile program.

$15,000,000—**General Dynamics Corp.,** San Diego, for installation and checkout of *Atlas* operating sites (supplemental contract).

$13,841,000—**Boeing Company,** Seattle, for missiles and related equipment.

$9,000,000—**General Electric Co.,** Philadelphia, for continued work on a classified project (supplemental contract).

$5,850,000—**Aerojet-General Corp,** Sacramento, for work on Stage II rockets for *Minuteman* missiles.

$4,470,598—**Ets-Hokin & Galvan, Inc.,** San Francisco, for installation of 1500 miles of cable for a *Minuteman* ICBM base at Minot, N.D.

$4,432,000—**Bendix Corp.,** Ann Arbor, Mich., for work on a classified project (supplemental contract).

$3,133,066—**General Dynamics/Pomona,** Pomona, Calif., for spare parts for *Atlas* missiles.

$2,000,000—**Boeing Company,** Seattle, for initial work on the fifth *Minuteman* wing to be located at Warren AFB, Wyo.

$1,800,000—**North American Aviation, Inc.,** Canoga Park, Calif., for engineering support for *Atlas* missile engines.

$1,150,000—**Minneapolis-Honeywell Co.,** St. Petersburg, Fla., for work on the *Dyna-Soar* guidance subsystem (supplemental contract).

$1,345,000—**General Dynamics Corp.,** San Diego, for spares for the *Atlas* missile program (supplemental contract).

$900,000—**Sperry Gyroscope Corp.,** Geat Neck, N.Y., for stable platforms used in the *Minuteman's* inertial guidance system.

$480,000—**Hughes Aircraft Co.,** Culver City, Calif., for *GAR-11 Falcon* missiles and descriptive identification data.

$192,463—**Martin Marietta Corp.,** Baltimore, for replacement parts for the *TM76A* missile system.

United Technology Corp., Sunnyvale, Calif. for developing the 120-in. solid segmented rocket engines for the *Titan III* space booster to be developed by the Martin Marietta Corp. (undisclosed amount).

ARMY

$7,779,600—**General Dynamics/Pomona,** Pomona, Calif., for continuation of work on the *Mauler* missile system.

$5,000,000—**Radio div. of the Bendix Corp.,** Baltimore, for design and construction of ground terminals for the *Syncom* satellite communication system.

$364,396—**Western Electric Co.,** New York City, for technical assistance in support of the operations and maintenance of the *Nike* systems.

$140,000—**Nortronics, div. of Northrop Corp.,** Anaheim, Calif., for *Hawk* launchers.

$60,473—**Gilfillan Bros. Inc.,** Los Angeles, for repair parts for *Corporal* missile system.

$60,126—**Sperry Utah Co.,** Salt Lake, for *Sergeant* test equipment.

$49,520—**Stanford Research Institute,** Menlo Park, Calif., for study of *Nike-Zeus* capabilities.

What's happening at WESCO



PRISM . . . WESCO's maintenance program (PRogramed Integrated System Maintenance) has been applied effectively to ordnance installations in Guided Missile Destroyers. PRISM is being expanded to other classes of ships and equipments, and to industrial use. The concept is currently being applied to maintenance of Polaris equipments.

DO-CONS . . . WESCO has developed strong capabilities in DOcument-CONtrolled Systems. This unique concept supports the disciplines of research, development, production and use. Following successful participation in the Polaris program, WESCO is at present planning a DO-CONS program for Apollo.

TRAINING . . . WESCO's experienced staff has trained diverse engineering groups in concepts of system engineering under contract with the Department of the Navy. Excellent results have led to expanded efforts in additional facets of this training program.

EXPANSION . . . To support the increased demand for these services, WESCO recently opened new main offices in suburban Washington, D. C., doubling the previous facilities. This move follows the establishment of a branch in Cambridge, Massachusetts, and preludes a planned facility in Houston, Texas. Now, more than ever, WESCO is ready to meet system design and analysis support requirements of Government agencies and industrial clients.

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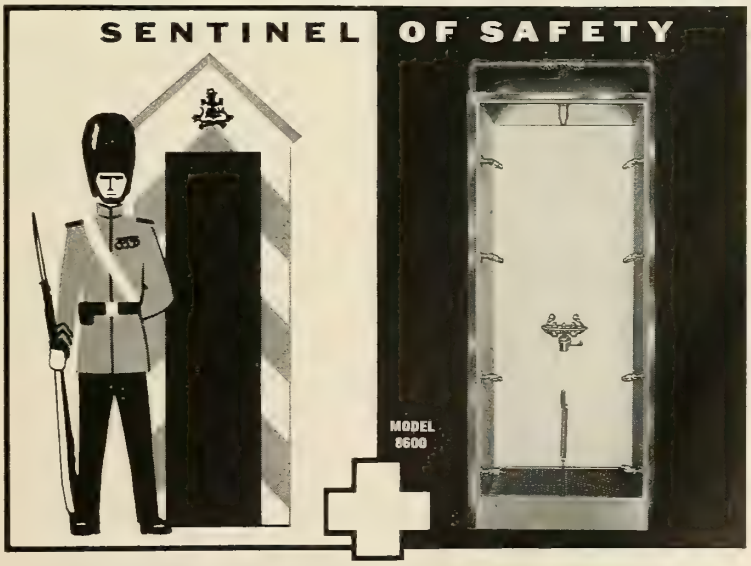
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$26,500,000—**Bendix Corp.**, Mishawaka, Ind., for the *Talos* missile system.

$2,100,000—**Steel Improvement and Forge Co.**, Cleveland, for production of propulsion system components for the *Polaris* missile.

$1,125,000—**Republic Aviation Corp.**, Farmingdale, N.Y., for *Polaris* diving training equipment.

$215,000—**Lockheed Aircraft Corp.**, Sunnyvale, Calif., for trace acceptance testers; operate test sites and cable sets to interconnect *Polaris* missile system.

NASA

$16,000,000—**A.C. Spark Plug division of General Motors Corp.**, Wakefield, Mass., for fabrication of the inertial platform for the *Apollo* guidance system with associated electronics, and for development and construction of a guidance ground support and checkout system. Engineering and design will be done at Wakefield and production will be done in Milwaukee.

$2,000,000—**Raytheon Co.**, Bedford, Mass., for manufacture of *Apollo* guidance system's on-board digital computer.

$2,000,000—**Kollsman Instrument Corp.**, Elmhurst, N.Y., for building the optical subsystems including a space sextant, sunfinders and navigation display equipment for the *Apollo* guidance system.

$1,200,000—**Documentation Inc.**, Bethesda, Md., for providing the first completely-integrated technical information center dealing in the space and aeronautical sciences.

$157,696—**Martin Marietta Corp.**, Baltimore, for studies and experimental investigations of tasks in connection with lunar-landing rendezvous and re-entry.

AEC

Martin Co., Baltimore, for study of the application of space-age miniaturization to the development of small, lightweight power plants for use in remote areas of the Earth (undisclosed amount).

INDUSTRY

$2,000,000—**Marquardt Corp.**, Van Nuys, Calif., from **North American Aviation Space and Information Systems Div.**, for Project *Apollo* spacecraft reaction control rocket engines.

$830,000—**Systems div. of Beckman Instruments, Inc.**, Fullerton, Calif., from **Rocketdyne Div. of North American Aviation, Inc.**, for data acquisition equipment to be used in static-testing rocket engines.

$600,000—**Tenney Engineering, Inc.**, Union, N.J., from the Italian government for advanced space simulation equipment.

$500,000—**Acoustica Associates, Inc.**, Los Angeles, from **General Dynamics/Astronautics**, San Diego, for site activation work on the *Atlas F* missile program (supplemental contract).

$79,632—**Fabri-Tek, Inc.**, Minneapolis, from **Hughes Aircraft Co. El Segundo div.**, for a subassembly of the *Polaris* missile guidance computer.

General Electric Co., Lynn, Mass., from **McDonnell Aircraft Corp.**, for development of the fuel cell battery for the *Gemini* spacecraft.



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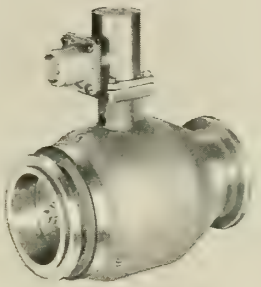
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Hardware?

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HOW TIMES HAVE CHANGED

Now we're up around Mach 5 and altitude has been pushed into outer space. Nose cones light up like giant soldering irons and components have to operate in a near vacuum.

Fortunately, Amphenol engineers saw that the old "hardware" concept was headed out the window. Programs coming up were going to need connectors that could put up with terrific environmental conditions of heat and altitude cycling. For example, at high temperatures most of the elastomers used as insert materials or connector seals either melt into a puddle, turn into a cinder, or set-up and lose compression.

What's more, connectors now have to keep on functioning *all* the time, with no allowance for failure. So—Amphenol designers went to work developing a connector to meet the new space-age standards.

DISSECTING MOLECULES

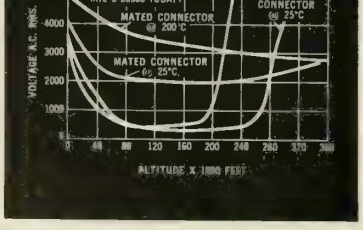
The Amphenol Materials Lab, with the help of a shiny new infra-red photospectrometer, began dissecting elastomer molecules. They were able to pinpoint the weak spots in molecular structure where breakdowns begin. Then they were able to plan and build new molecules, with built-in "armor" to protect against failure. Result: an exclusive silicone rubber compound that maintains its integrity and elasticity under severe temperature extremes and also withstands exposure to violent new propellants like hydrazine and nitrogen tetroxide.

At the same time, Amphenol design engineers were hard at work perfecting metal-to-metal shouldering of mating shells that allowed precision control over compression of the sealing ring. In addition, the metal-to-metal design damped vibrational stress nine times more effectively than resilient damping. Finally, they incorporated a semi-rigid anti-deflection disc to control insert expansion under thermal stress.

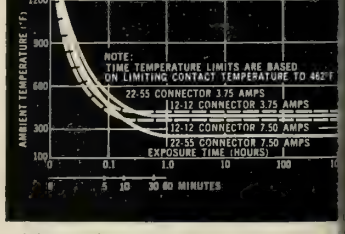
Having all the pieces, we put them together, called it the Amphenol 48 Series, and started testing. In the vacuum chamber, 48 Series connectors operate very nicely at a simulated altitude of 500,000 feet. They are quite comfortable in the hot box at 200° ambient, *carrying full rated current*. They don't even mind going up to 600°C, if they don't have to stay too long. In short, Amphenol 48's can take almost anything you throw at them.

PROJECTS WANTED

Amphenol designers have established criteria for determining connector time-temperature-current capability. This information will be especially valuable to engineers presently engaged in "exotic" projects, perhaps the kind of project where previous connectors have failed to measure up to the new space-age standards. If this is the case, contact an Amphenol sales engineer. He's a "space-age hardware" expert. Or, write directly to Bob Dorrell, Vice President, Engineering, Amphenol Connector Division, 1830 South 54th Avenue, Chicago 50, Illinois.



High altitude air has low dielectric strength. By maintaining an air-tight seal 48 Series Connectors enjoy extremely high voltage safety factors.



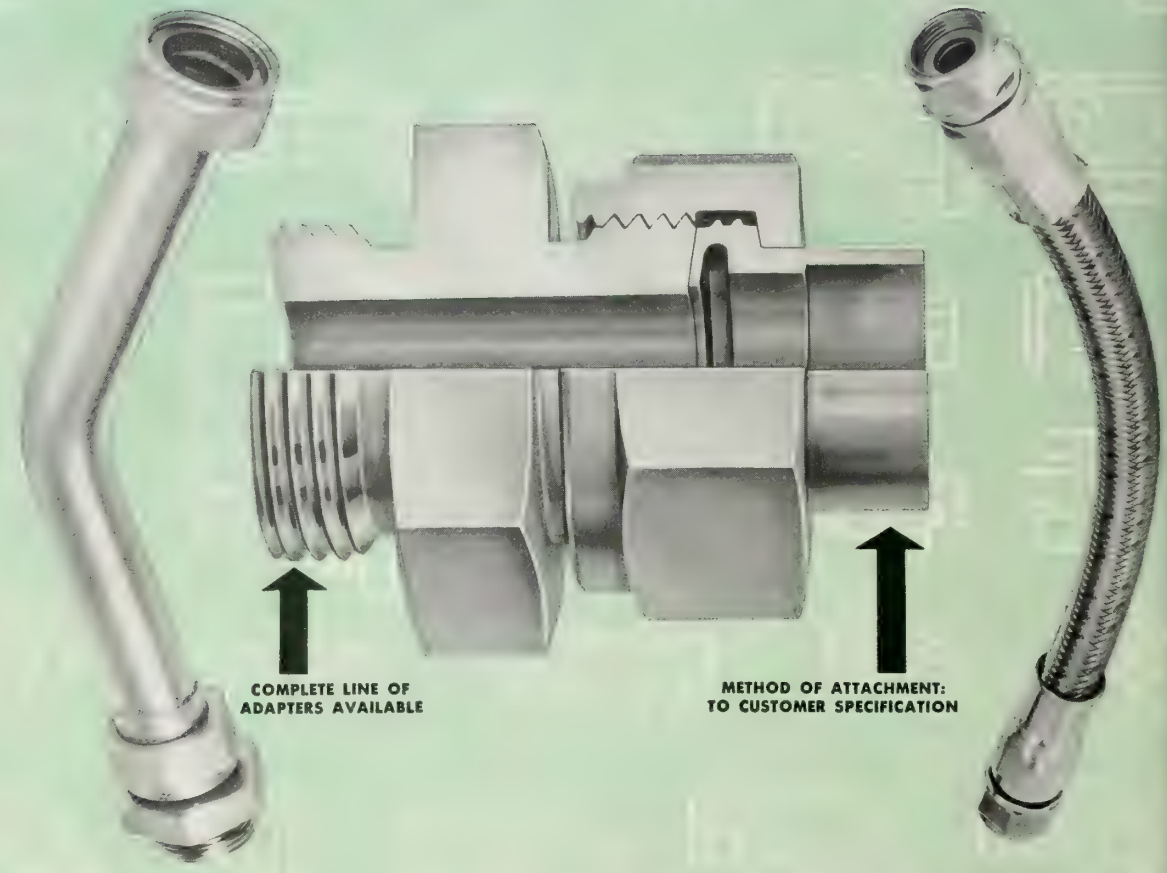
While Amphenol 48 Series Connectors are nominally rated at 200° C, they can also withstand considerably higher short-time temperature exposures.

Amphenol 48 Series Meets Mil C 26500 (USAF)

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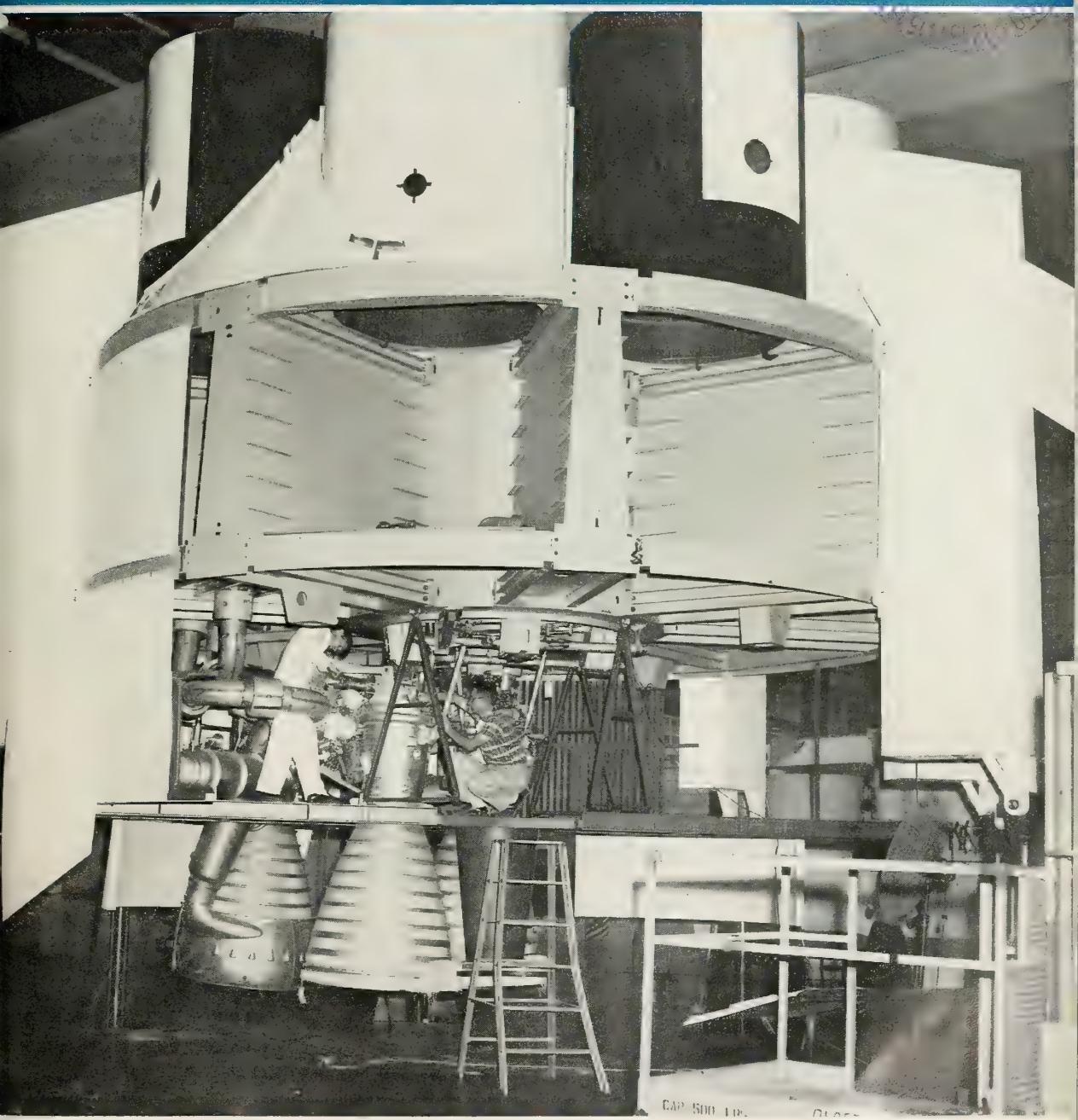
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May 28, 196

missiles and rockets

HE WEEKLY OF SPACE SYSTEMS ENGINEERING



Saturn SA-5 Mock-up Gets Tail Fins

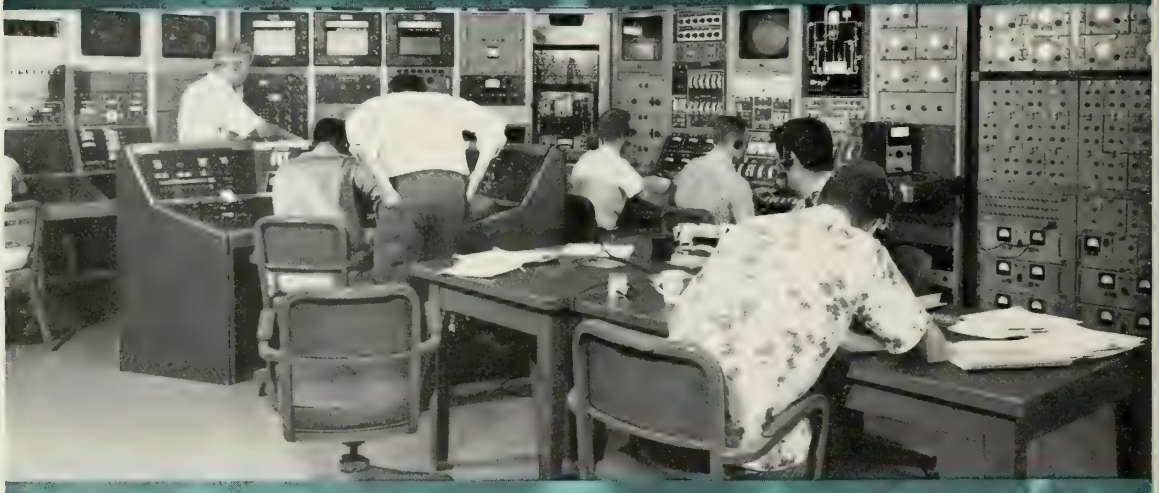
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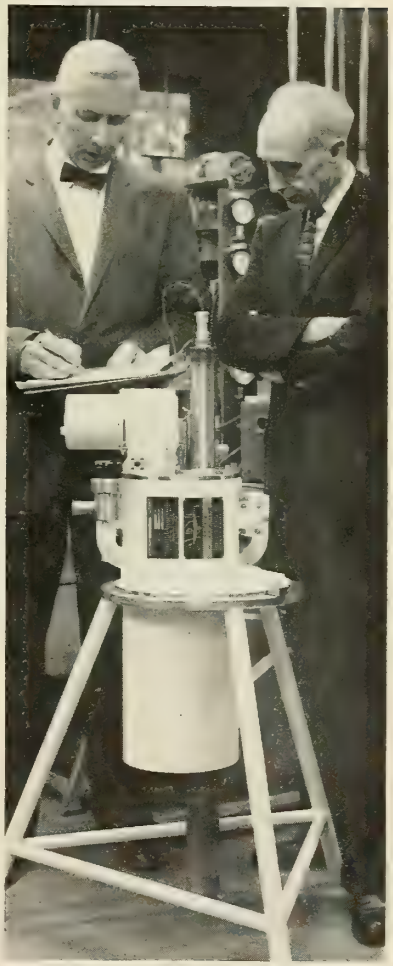
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Albert Hatch (left) and Dr. Howard McMahon discuss the results of a test run. Dr. McMahon and William E. Gifford, now Professor of Mechanical Engineering at The University of Syracuse, were co-inventors of the refrigeration cycle used in the CRYODYNE Refrigerator. Albert Hatch is in charge of engineering development of the Refrigerator at ADL.

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A BLAW-KNOX "FIRST" ON PROJECT NIMBUS

NEW "X-Y" MOUNT PREVENTS GIMBAL LOCK

A new project, operated by the Goddard Space Flight Center of the National Aeronautics and Space Administration, is getting underway at College, Alaska. An 85-ft. Blaw-Knox Antenna will be used for advanced meteorological satellite projects.

Blaw-Knox has designed and built many 85-ft. antennas before, but this application called for even greater tracking precision so a new "X-Y" mount was designed that *eliminates gimbal lock at zenith.* The antenna is capable of moving through zenith position to all parts of the horizon. This is the *first* such mount to be put in service. This was a Blaw-Knox concept—a Blaw-Knox design—and Blaw-Knox precision construction.

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THE WEEKLY OF SPACE SYSTEMS ENGINEERING

missiles and rockets

Volume 10, Number 22 May 28, 1962

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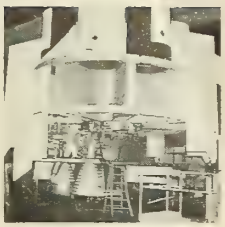
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THE COVER

Technicians at NASA's Marshall Space Flight Center work on mock-up of Saturn SA-5 (fifth flight vehicle). Tail fins will appear for first time on the SA-5.



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ORIGINALYSIS IN SPACE

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letters

Reaction to Titov

To the Editor:

Congratulations on your May 14 editorial ("Go Home, Russian"). I was annoyed at the amateurish propaganda attempt of Titov, but I was shocked at the obvious efforts of some of our TV commentators and reporters who were trying so hard to be good press agents for him and assist him in his propaganda efforts.

Our press, radio and TV too often become a tool of the Communists by accepting, and repeating as fact, all statements by the Communist Propaganda Machine. We should consider the purpose of all statements from Communist sources, and not accept them as fact unless truly substantiated.

Joseph A. Chambers
Vice President
Motorola Inc.
Scottsdale, Ariz.

To the Editor:

Just a word concerning your editorial of May 14—

BRAVO.

I spent eight years in the daily newspaper racket before returning to engineering, and a good portion of the time was spent trying to convince the public to be wary of Red double talk—a la spaceman. Glad to see someone is taking up where I left off.

If you will check an ephemeris of the moon for the time of the supposed Titov flight you will find that the very dim (compared to full moon) crescent of the moon was shining mainly on the daylight and twilight side of the Earth. Despite this fact Titov reported at an early news conference that the moon shine on the dark side of Earth was striking. This and a few other bloopers have long ago convinced me that Titov got his space knowledge from someone else.

Lewis Dewart
Sunbury, Pa.

To the Editor:

I should like to thank Titov and company for renewing my patriotism and faith in my country. Prior to Titov's visit I lived in a state of emotional apathy which no VFW or American Legion fife and drum corps could eliminate. The war years and subsequent struggles had taken something out of me. But after hearing that Russian fake I left the State Department auditorium, went around to the front entrance and gazed up in reverence and humility at our flag.

Ray Benton
Baltimore

To the Editor:

Your May 14 editorial was right on target.

Did we really expect Major Titov's visit to be anything more than a barrage of propaganda potshots

I don't think we did.

Stephen N. Bowen
The Lubrizol Corporation
Cleveland

Engineers and Degrees

To the Editor:

The controversy still rages! The "Applied Scientist," Mr. Harold Weinbaum (Letters, M/R, May 7, p. 6) bombards the technician without a degree and goes along with Mr. Nawrocki's earlier letter ("Who's An Engineer?") suggesting that the Engineer without a degree pass a "final examination at a recognized college and be awarded full credit toward a degree."

Would not Weinbaum and Nawrocki agree that if the same degreeless "Engineer" were to pass a written examination for a professional engineer's license in the state in which he was resident and in the "area of engineering" he was specializing in, that this would qualify him beyond a shadow of doubt? Mr. Weinbaum certainly must know that a degree in Engineering does not qualify the recipient to call himself an engineer. Under the various state laws governing the practice of Engineering no one may call himself an engineer until he has qualified for and passed an examination for professional licensing.

There have been many leaders and pioneers of "Applied Science" in these United States and throughout the world who never had a formal education—in some cases not even the rudiments of an education. Among these were Wilbur and Orville Wright and Thomas Alva Edison. Further back and in a less exotic field, what about Sir Charles Arkwright, the inventor of the first practical cotton spinning loom powered by a horse? Again, Peter Cooper, an "engineer" and inventor of considerable capability. And again, in modern times, a self-educated engineer, Mr. Ralph Roe, president of Burns and Roe, considered one of the foremost engineers in the steam-powered electric generating fields.

I must take exception to Mr. Weinbaum's statement, "Of course, there are always exceptions to the rule."

What rule does he refer to? Mr. Weinbaum's doubts as to whether these so-called engineers have the vision to develop a new idea, to "see" in their minds the necessary steps in planning prototype equipment, is the most idiotic statement I have ever read. Does he infer that all engineers with degrees have this elusive mental capability inherently as a result of the degree? . . .

The ability to "see"—i.e., imaginative engineering plus the application of scientific logic—is not a quality of the many and certainly is not limited to, or the exclusive property of, the man with the degree. It is a blessing reserved to few of us—though there are those who would strongly deny this. . . .

I would suggest that Mr. Weinbaum reappraise the source of confusion he states exists, and reapply for that elusive Government assignment he thinks he fits.

Benjamin Gray
Registered Architect
Professional Engineer
Nanuet, N. Y.

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The Countdown

WASHINGTON

Atlas Will NOT Get Dominic Test

Despite "informed" reports of a reconsideration of the President's decision not to proof-test a complete *Atlas* ICBM in the current nuclear test series, the missile will definitely not be included. The Administration feels that the 3000-mile flight of the *Atlas* would involve too great a risk that it might stray out of the Pacific test area.

Space Station Tops AF Priority List

When the Defense Department holds its comprehensive review of the military space program (expected during the next six months), it will find the Air Force pressing hard for a Manned Military Test Station. With many AF programs now reaching the test stage, the MMTS, an AF spokesmen says, provides "the only reasonable solution" to testing space hardware.

R&D Code of Conduct Pushed

President Kennedy has instructed each Federal department and agency doing R&D work to develop standards of conduct for personnel working under contract. The order was contained in a covering letter in disseminating the Budget Bureau report on government R&D contracting. To be worked out with the Attorney General, the codes of conduct are to provide conflict-of-interest standards "to guide the public officials and private persons and organizations engaged in research and development activities."

Some Say Nix to Nova

NASA's current review of the Manned Lunar Landing Program has given critics of the *Nova* super-booster another chance to be heard. These opponents—some of them NASA officials—feel that the *Advanced Saturn* is about as big as a chemical booster ought to get. They say that now is the time to push nuclear powerplants—particularly high-thrust heat exchanger systems and nuclear electric vehicles. They argue that a nuclear fission or fusion is the ultimate, and only truly realistic, power system for space exploration—and can be available in the early Seventies, if development starts now.

Trouble at the Motel

NASA has laid down a strict policy regarding astronauts' commercial enterprises, in order to forestall public criticism, COUNTDOWN has been told. Among other things, the space agency is understood to have told the seven astronauts they would not collect regular per diem payments if they stayed at their own Cape Canaveral motel, the Cape Colony Inn, and that NASA would hold no official functions there. In addition, top NASA officials are expected to avoid the motel out of fear of criticism. There's a growing feeling the astronauts have been poorly advised on their commercial ventures, creating unnecessary public disapproval.

Hooks Due to Depart

Maj. Gen. D. E. Hooks, commander of the Air Force's Office of Aerospace Research, is expected to retire shortly, probably about June 1. There are no obvious frontrunners to replace him.

INDUSTRY

'Aerospace Island' Begins to Sink

The "Aerospace Island" envisioned by planners of the 1964 New York World's Fair (M/R, April 9, p. 36) seems to be fading fast. The American Rocket Society, the hoped-for sponsor, has agreed to "stand ready to provide technical consulting advice and assistance," but has turned down the job of actually organizing and managing the huge space display. Observers blame the heavy financial risk involved, which has made interested aerospace firms reluctant to put up the required cash.

Industry Hits DOD 'Over-Management'

One of the chief complaints of industry officials at the AFSC's Management Conference was an alleged tendency by DOD to over-manage its contractors. Specifically, the critics charged that the DOD directive establishing a Defense audit coordinator would, if interpreted literally, make that official "a key member of each company's top management team." Another area of concern is the Department's continuing demand for management reports containing information that in commercial enterprises the customer is not entitled to have.

Aerojet Slashes Processing Time

Aerojet-General reports that a dividend from the manufacture of the nation's first few giant solid rocket motors will be greatly decreased processing costs in the future. It says a dramatic slash of 65% in man-hours and 39% in time required was achieved in less than a year of processing center segments. The savings were a direct result of Aerojet's building and firing three 100-in.-dia. motors for the Air Force Large Rocket Motor Program.

INTERNATIONAL

Blue Water Rumors Scotched

Reports that the English Electric *Blue Water* surface-to-surface missile might be scrapped have been emphatically denied by both the British government and British Aircraft Corp., English Electric's parent company. Air Vice Marshal W. C. Sheen (RAF, ret.), BAC's director of military projects in the U.S., says a British Ministry of Defense spokesman has reaffirmed that *Blue Water* "will most certainly be taken into service by the British Army" and that the British are still hoping it will be adopted by NATO. *Blue Water* and the U.S. *Sergeant* are both being considered by NATO.

Italy Studies Ionosphere Probe

Italy's National Institute for Space Research is considering use of a mobile launching platform to orbit a scientific satellite to measure local density of the upper atmosphere in the equatorial region. Called the S. Marco project, the satellite would be placed in a low equatorial orbit to examine electric and ionospheric characteristics.

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The Missile/Space Week

Shots of the Week

Test pilot Bob Rushworth took the *X-15* through a series of 2000-ft. humps at Mach 5 to test air current flow around the craft during maneuvering. He reported that the roller-coaster-like ride produced strange noises, similar to buffeting, in the successful flight. The rocket plane hit 97,000 ft. three separate times in the May 22 test run. No control problems were experienced.

In other shots:

- The Air Force launched a tenth *Minuteman* from a silo at Cape Canaveral May 18. The Boeing missile streaked 3000 miles downrange in a perfect flight. The silo launching was the 9th success in 10 tries.
- The second of three U.S.-Japanese ionospheric probes was launched from Wallops Island May 23, using a *Nike-Cajun* rocket. The payload was designed to measure both temperature and density. The third and last launching of the cooperative program was scheduled for later the same day.
- At Point Arguello, the Air Force attempted on May 23 to orbit a satellite launched by its *Blue Scout* solid rocket.

Boeing, GD/A Face McClellan Probe

Earnings on $1.6 billion worth of *Bomarc* missile work over an 11-year period by the Boeing Co. came under close scrutiny by the Senate Permanent Investigations Subcommittee of Sen. John L. McClellan (D-Ark.)

Figures purporting to show that Boeing made before-taxes profit ratios on net worth of from 36% to 108% were introduced by Thomas E. Nunnally, a government accountant.

Boeing, Nunnally said, did $11,818,900,000 in government business and $1,346,600,000 in commercial business in the 1950-61 period. Before-taxes profit on the government work amounted to $907,700,000—or less than 10% of the military sales. In the same period, he said, the company's net worth went from $53.9 million to $259.3 million.

Using the year 1954 as an example, Nunnally showed that Boeing had a before-taxes profit of $73.3 million on government sales against a 1953 net worth and net investment of $82.2 million.

By this standard, he said, Boeing's profit to net investment was 100.1%. The assessments of excess profits by the Renegotiation Board were not deducted from his figures, Nunnally added. The Company's after-taxes profit in 1954 on government business, he said, was 48% and on all business 33.78%.

In Seattle, Company officials disputed the committee's use of the net investment criteria, rather than sales volume, as a measure of profits.

Subsequent hearings indicated that Air Force officials had rejected Boeing proposals for fixed-fee contracts for *Bomarc* work and insisted on the use of incentive contracts in spite of the fact that firm cost data was not available as a basis for such contracts.

Representatives of both Lear, Inc., and ITT Federal Laboratories testified that, after the conclusion of incentive contracts, they found that the *Bomarc* components which they manufactured could be produced for substantially less than they originally estimated.

Figures were also introduced to attempt to show that Boeing made more profit on work done by subcontractors than the subs themselves.

Appearing earlier, James R. Dempsey, President of General Dynamics/Astronautics, and Arthur L. Malcarney, Group Executive vice president of RCA, defended the profits made by the companies on *Atlas* work as fair and reasonable.

Both pointed to the outstanding performance of their companies in the development and production of the *Atlas* system. GD/A's performance in the *Atlas* program, Dempsey said, "has not been equalled in any weapon system developed since World War II."

A Subcommittee assistant counsel had introduced figures purporting to show that associate prime contractors and subcontractors earned profits of 17% on $16,924,261 of costs for *Atlas* D launch control system procurement.

Design Error Caused Centaur Failure

The failure of the *Centaur* 54 seconds after launch May 9 was caused by a flaw in the design of the weather shield between the nose fairing and the *Centaur* itself.

The failure was blamed on "an

engineering mistake," said Grant L. Hansen, vice president of General Dynamics/Astronautics, who appeared before the House Space subcommittee investigating the *Centaur* development delay.

ComSat Bill Clears Hurdle

The Senate Commerce Committee has approved legislation setting up a privately owned communication satellite system.

It appeared however, that it would not reach the Senate floor for a vote for at least another two weeks.

The bill retained the main features of a measure already approved by the House and by the Senate Space Committee. A shift in emphasis on who shall own and control ComSat ground stations was the only major difference. The Committee changed language favoring ownership of the stations by private communications companies and directed that the Federal Communications Commission make its ownership decisions without preference either for the corporation or for the companies. Other revisions were chiefly of a clarifying nature. The corporation is to be owned 50-50 by individual investors and the private communications industry, and three of its 15 directors are to be selected by the White House with the Senate's consent.

MA-7 TV Experiment

A television-telescope was set up at Cape Canaveral last week for an attempt to follow Astronaut Scott Carpenter's *Aurora-7 Mercury* capsule on its scheduled orbital flight Thursday.

The Air Force said the "revolutionary" device would be trained on the capsule as it went into orbit and when it crossed over Florida on its first trip around the Earth.

Informed sources said the telescope had been used earlier to photograph U.S. and Soviet space vehicles.

Two early holds on the *MA-7* launch were caused by problems with the drogue parachute deployment system and a temperature-control component in the *Atlas* flight control system.

On John Glenn's *MA-6* flight, the drogue shoot broke out at 28,000 ft. instead of the planned 21,000 ft. NASA engineers ran exhaustive tests but were unable to find the cause of the malfunction. Finally, they installed an extra barostat circuit to prevent premature parachute ejection.

The new set-up provides for pilot manual deployment of the drogue at 21,000 ft., with automatic deployment at 11,000 ft.

The temperature-control component was quickly disassembled, replaced and re-tested.

New Saturn Plant To Go Up

North American Aviation Inc. will build a $7.5-million assembly and test facility for the second stage of the *Advanced Saturn* booster.

The new facility will be located in Seal Beach, Calif. Construction will begin early this summer and is expected to be completed in 18 months.

The second stage of the *Advanced Saturn* is being developed by North American's Space and Information Division. The 10-vehicle development program is estimated by NASA to have a total value of $300 million. The stage will be powered by five J-2 liquid hydrogen engines with a total thrust of 1 million lbs.

Stack Joining Republic

John Stack, recently retired as NASA's director of aeronautical research, will become vice president and director of engineering of Republic Aviation Corp., effective June 1.

Stack, whose aerospace contributions have won him many awards including two Collier Trophies, will be in charge of Republic's scientific and engineering activities.

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In routine report . . .

NASA Gives Data On 'Secret' Shots

Lack of coordination with Air Force is apparent reason for disclosure; anti-classification arguments are renewed

by James Trainor

ORBITAL DATA on previously "classified" AF space shots has now been made public—in spite of a DOD directive forbidding the release of such information.

Reflecting an apparent lack of coordination between government agencies, the information was contained in a routine report issued regularly by NASA's Goddard Space Flight Center.

In effect making a mockery of the Defense Department's secrecy policy, the report lists all of the orbital parameters normally given for a satellite, leaving out only the Code, or Project, name of the spacecraft (see chart below).

For the past six months, the Air Force has been allowed to announce only the type of booster used in a particular launch, with the notable exception of *Discoverer XXXVIII*, which was launched Feb. 27 and recovered in the air on March 21.

To illustrate the extent of the information curtain, the AF on April 17 reported it had launched a satellite into orbit from Vandenberg AFB using a *Thor-Agena B*. No other information was released—not even the time of day at which the launching had taken place.

In contrast, NASA's report on the same launching shows that the vehicle went into orbit at an angle of inclination to the equator of about 73 degrees. Its apogee was 178.2 miles, its perigee 119.4 mi. and its period 89.5 min. The report also shows that three of the four orbiting objects from the launch decayed April 20 and 21.

Using these data plus the type of launch vehicle and the location of the launch, a reasonable deduction can be made that this was a *Discoverer* satellite.

• **Why the secrecy?**—Although the contents of the March 23 directive have not been made public (the directive itself is classified secret), there are reported to be two major reasons for restriction of information on military launches.

The first is a conviction on the part of some Administration officials that publication of this information gives the Russians valuable information which they might not otherwise have available.

Officials who oppose the secrecy policy point out, however, that the Russians have available the same electronic means the U. S. uses for acquiring these data. Also, they note, the fact that we still announce the launches further simplifies the Soviet tracking task.

"Who does DOD think they're hiding these things from?" one AF official asks sarcastically.

The second reason for secrecy appears to be the approaching operational

(Continued on page 52)

*Orbital Data on "Classified" Air Force Satellites**

Launch Date	Launch Vehicle	Site	Period (min.)	Apogee (Stat. Mi.)	Perigee (Stat. Mi.)	Inclin. (deg.)	Remarks
11/22/61	Atlas-Agena B	Pt. Arguello	——	——	——	——	In spite of AF statement of "successful launch", the satellite apparently did not go into orbit.
12/22/61	Atlas-Agena B	Pt. Arguello	92.5	336.0	133.8	89.6	Probably a Discoverer-type vehicle with components for SAMOS; also backup launch for Nov. 22 failure.
2/21/62	Thor-Agena B	Vandenberg AFB	——	——	——	——	Backup vehicle for Discoverer 37 which failed Jan. 15. Payload ejected from orbit and probably recovered Mar. 9.
3/7/62	Atlas-Agena B	Pt. Arguello	93.5	381.6	149.4	90.78	A Discoverer-type vehicle with SAMOS components most likely, capsule ejected and probably recovered March 31.
4/9/62	Atlas-Agena B	Pt. Arguello	153.0	2027.4	1668.4	86.68	MIDAS V; also carried a proton damage experiment to measure space radiation; capsule down May 4.
4/18/62	Thor-Agena B	Vandenberg AFB	89.5	178.2	119.4	73.45	Probably a Discoverer carrying components for support of nuclear tests.
4/26/62	Blue Scout	Pt. Arguello	——	——	——	——	Payload designed to provide data on effects of nuclear tests which began Apr. 25. Satellite down April 28.
4/26/62	Atlas-Agena B	Pt. Arguello	90.0	218.4	106.2	73.07	Discoverer vehicle also probably to measure effects of nuclear tests; capsule ejected May 1.
5/15/62	Thor-Agena B	Vandenberg AFB	94.0	387.6	174	82.45	Discoverer; no attempt so far has been made to eject capsule.

* Information contained in chart includes only that not previously available to the press. Other shots occurring during the time period on which data was available are not reported.

Reactor Delays Slow Nuclear Program

Reactor selection awaits further testing—so does actual fabrication under Lockheed's RIFT award

by Hal Taylor

LONG DELAYS in reactor test-firings have put the U.S. nuclear rocket program behind schedule.

The slippage will probably postpone actual engine and vehicle stage procurement until mid- or late 1963. For the further future, it raises the clear possibility that the 1968-69 target date for an operational nuclear upper stage is too optimistic.

The delays in the program were learned by MISSILES AND ROCKETS as NASA announced the award of an estimated $180-million *RIFT* development contract to the Lockheed Missiles and Space Co.

They were revealed by Harold B. Finger, director of the joint NASA-AEC Nuclear Propulsion Office.

Finger said that the program is "several months behind schedule."

There is evidence, however, that the delays may stretch even longer.

• **Key selection**—NASA has planned to select a reactor to power the nuclear vehicle this year.

On such a selection, Finger has told Congress, depends the space agency's nuclear rocket flight-test schedule and the commitment of major engine and vehicle procurement and development. To accomplish that goal, NASA had planned a reactor test-firing once every two months throughout 1962.

Up to this time, however, not one firing has taken place—and none is even scheduled until early summer.

The last reactor test was conducted on Dec. 7, 1961. At that time, a KIWI B reactor using gaseous hydrogen was test-fired.

Although the test was cut short because of a hydrogen leak, officials termed its results encouraging.

Among the important information gained from the test, according to NASA:

—Evaluation of the effectiveness of the use of control rods in the reflector portion of the reactor to control the neutron power generated by the system.

—The first preliminary hot tests of a hydrogen-cooled jet nozzle intended for use in reactor testing.

—Preliminary evaluation of one of the several reactor designs that will be evaluated in the KIWI B reactor series.



SMALL scale model of Lockheed's RIFT.

The next step in the development schedule was the test-firing of a KIWI B reactor using liquid hydrogen as propellant. This is the reactor NASA hopes to incorporate in the nuclear rocket. The test was slated for early 1962, but has not yet taken place.

The new NASA schedule calls for the firing in July or August.

Space agency officials have given no reason for the delay in the reactor test firings, but it may stem from an evaluation of the results of the December test. Part of the problem may also have been caused by an explosion which occurred at the Nevada test site late last year.

Once the liquid-hydrogen reactor test series begins, several different types will be tested. This will almost certainly put off the selection of a reactor for the program until sometime next year.

• **The RIFT job**—As soon as that decision is made, Lockheed will be able to move ahead on actual fabrication work under the *RIFT* contract—which will prove to be one of the most valuable awards in the U.S. civilian space program.

The contract calls for the development of 10 vehicles at a total cost of $180 million. One will be a boiler-plate model, five will be used for static-test firings, and four will be flight-test versions.

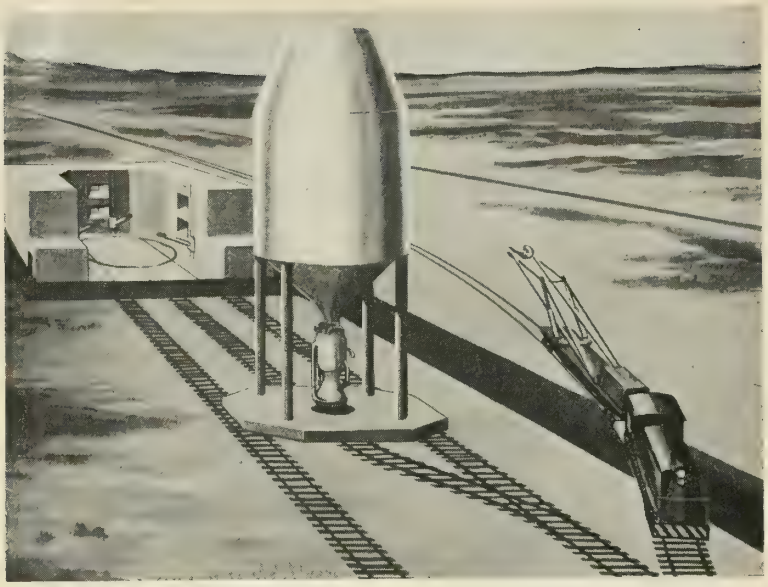
Space agency officials report, however, that quite a few more stages probably will be needed for the follow-on test-flight program.

In addition, it is expected that the operational *RIFT* vehicle will incorporate many changes gleaned from the test program, and an additional contract will have to be signed to cover its development.

Lockheed will be by far the leading contender among missile/space firms for that award.

Its current contract covers the design, development, fabrication and testing of the *RIFT* stage. First phase of the contract will run six to nine months, according to NASA, and provide for design and research work leading to a fixed configuration.

The second phase will cover actual fabrication, with the first completed vehicle scheduled for late 1964.



NASA DRAWING depicts facilities which will be used to remove radioactive engines from launch vehicle. Construction at Nevada test site will begin this year.

Design and non-nuclear testing of the components will be done at Lockheed's home plant in Sunnyvale, Calif. Major assembly of the vehicle is planned for NASA's Michoud plant in Louisiana. Space agency officials report that overcrowding at Michoud may eventally force a new assembly location.

Work in support of the assembly, such as design and assembly tooling as well as some component manufacture, will be performed by Lockheed's Marietta, Ga., and Burbank, Calif., plants. It is expected that about 200 contractor personnel will be involved.

Ground static-tests will be at the Nuclear Rocket Development station in Nevada. Dynamic testing will be performed at the Marshall Space Flight Center, using advanced *Saturn* development facilities.

• **Planning**—*RIFT* will be 33 ft. in diameter with a height of over 100 ft. First test-flight will be made in 1966-67 period using the *Advanced Saturn* booster with a dummy second stage. The total vehicle will stand 300 ft. high.

Of the four test-flight models, which Lockheed will build, only the first will have a dummy reactor.

During the three flights with live reactors, a two-stage lob-shot flight will be made. NASA plans call for launch with the reactor cold and not operating until the *Advanced Saturn* booster separates. The *RIFT* vehicle will impact some 500 miles downrange from Cape Canaveral, where it will sink in 6000 ft. of water. The reactor will be destroyed before impact.

Launch pad No. 39 at Cape Canaveral will be modified for *RIFT* launches. In addition, the construction of $50-million worth of test facilities at the Nevada test site is expected to begin later this year.

RIFT will be shipped overland by truck to Nevada from Port Hueneme, Calif., after coming by barge from its Gulf Coast test and production facilities.

Two other missile space firms—the Martin Co. and General Dynamics/Astronautics—competed for the contract during its final selection phase.

No mission has yet been assigned to *RIFT* although it is expected to play a major role in later manned and unmanned interplanetary flights.

It might also be used for flights in Project *Apollo*, but this appears extremely unlikely except for later manned lunar landings.

To provide for such a contingency, NASA has designed its *Advanced Saturn* booster so that a nuclear upper stage can be incorporated when it is developed. Such a booster would double the payload capacity of an all-chemical three-stage *Advanced Saturn* booster and is higher than the *Nova* 12-million-lb. thrust booster.

NASA has asked Congress for $25 million for the *RIFT* program in its Fiscal 1963 budget. All indications point to Congressional approval. Many officials in the nuclear rocket program feel that it has been inadequately funded up to this point and more money would speed its development immeasurably. ⁂

Lockheed Sets Up New Division to Handle RIFT Contract

LOCKHEED MISSILES & SPACE CO. has formed a new division to handle its multimillion-dollar contract for development of the nation's first nuclear-powered rocket stage.

Lockheed President L. Eugene Root announced the formation of the new Nuclear Space Program Division, which will be responsible for NASA's RIFT *program.*

Appointed Vice President and General Manager of the new division is Dr. Roy Smelt, who until his promotion was chief scientist of LMSC. Malcolm C. Williams, formerly Administrative Director of LMSC, has been appointed Assistant General Manager.

Dr. Harold F. Plank will be program director. Plank directed the LMSC RIFT *study activities that led to the company's successful bid for the* RIFT *program. Elmer P. Wheaton, who in April was elected a Vice President of Lockheed Corporation, will become Vice President for space programs. In this capacity, he will be responsible for all NASA-directed LMSC efforts.*

The company's RIFT *proposal team forms the nucleus of the new LMSC* RIFT *division organization, augmented by additional Lockheed executive, technical and managerial personnel. In this connection, Root announced the following directors of the nuclear space systems division to serve under Smelt, Williams and Plank: A. J. Steele, Engineering; G. J. Brenthall, Procurement; R. A. Mackenzie, Manufacturing; R. P. Della Vedowa, Product Reliability; L. L. Woodward, Test Operations; and R. W. Boesel, Program Control and Administration.*

The Nuclear Space Systems Division will be centered at the company's main plant in Sunnyvale, Calif.

Commenting on the contract award, Root said, "Lockheed, through studies and research program supported by NASA contracts and corporate funding, has been working in the nuclear space flight area since early 1958.

"We are appreciative, and enthusiastic in being chosen as a member of the NASA/Industry team to meet the challenge of testing out this very promising form of propulsion for space."

Sergeant Slated For Europe in 1964

SERGEANT — the Army's solid-fueled replacement for its *Corporal* surface-to-surface tactical missile—will be deployed with U.S. troops in Europe next year.

Highly mobile and air-transportable, the Sperry *Sergeant* represents a substantial improvement over its liquid-fueled predecessor. *Corporal,* presently deployed in West Germany and the U.S., is a cumbersome system whose mobility is severely restricted by the size and complexity of its ground support equipment.

Sergeant uses an inertial guidance system, rather than the preset and radio command system of *Corporal.* Also its solid-fuel rocket motors give it a marked advantage over the hypergolic fuel system used in *Corporal.*

In place of the caravan which must accompany a *Corporal* firing battery, the *Sergeant* needs only three vehicles and the trailer-towed launcher.

Equipped with a nuclear warhead, the *Sergeant* is expected to give the Corps Commander a flexible, accurate, high-firepower battlefield weapon.

Exactly where or when the first *Sergeant* battalion will be deployed was not revealed in the announcement last week by Secretary of the Army Elvis J. Stahr. The outgoing Secretary also would not say how many *Sergeant* battalions would be activated and deployed.

It is known, however, that the 1963 procurement of *Sergeant* missiles will essentially complete the Army's inventory objective, except for training missiles. The reason for this appears to be that although *Sergeant* represents a major improvement over *Corporal,* the system is still not an optimum corps support weapon.



SERGEANT will give U.S. Army troops greater firepower and mobility.

In addition to the *Sergeant* unit to be deployed next year, Stahr announced that two more battalions—the 3rd Missile Battalion, 81st Artillery and the 5th Missile Battalion, 77th Artillery—will be activated before June 30 of this year. They will undergo their training at the Army's Field Artillery and Missile School at Fort Sill, Okla.

Little Joe II to Aid Apollo

THE *LITTLE JOE II* solid booster to be developed by General Dynamics/Astronautics will have a maximum thrust of 250,000 lbs. with seven solid rocket motors.

It will be used for suborbital test flights of the *Apollo* spacecraft launch-escape, earth-landing, stabilization, and service-propulsion systems.

It will also be utilized for the partial qualification of the spacecraft structure and the propulsion system of its lunar-landing module.

Selection of GDA as the prime contractor for the launch vehicle was announced by NASA last week. Total value of the contract, which calls for development of five boosters, was not revealed. The space agency has, however, requested some $8 million for its development in the Fiscal '63 budget. Its total value will be much higher because the length of the award is expected to extend into 1964 or later.

Little Joe II development missions will take place in the 1964-65 period. They will be among the first flights in the Project *Apollo* program which has as its objective the landing of three astronauts on the Moon.

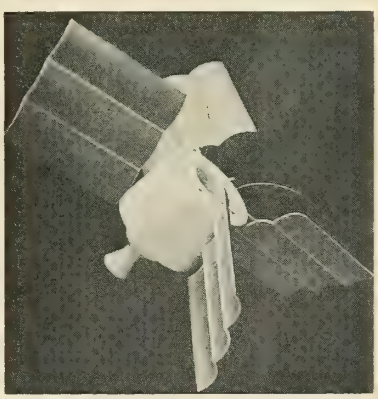
NASA did not reveal any information on the booster's various configurations. It is known that the number of solid motors will vary, with a planned maximum thrust of 250,000 lbs. It is expected the current *Scout* launch vehicle first stage will form the nucleus for the new booster.

The NASA announcement said that before the manned *Apollo* spacecraft is launched, suborbital test flights are required to prove out necessary safety provisions. *Little Joe II* will be designed as an economical and expendable launch vehicle to propel the spacecraft on the suborbital flights.

"We think this is an important program and we will treat it as such," said J. H. Famme, President of GD/Convair.

Famme said that design work on *Little Joe II* would start immediately and that work on the initial contract will extend to 1964.

Under the contract, GD/Astronautics will manufacture five of the launch vehicles and a launcher. It will also provide the necessary ground support equipment. J. N. Hurt, who has been appointed *Little Joe II* program manager, said the launch vehicle will be powered by solid fuel rocket motors in a cluster arrangement. He said provisions will be incorporated for firing in stages.



Japanese ComSat

JAPAN IS PLANNING to have three or four NEC-1 active repeater communications satellites (as shown above) in orbit in time for the opening of the 1964 Olympic games in Tokyo. Employing four flat solar batteries, one in each of the solar paddles, the 105.5-lb. NEC-1 (the initials stand for the company responsible for satellite development, the Nippon Electrics Company, Ltd.) will be launched into a stationary, 22,300-mi. orbit by U.S. space boosters. Selection of the launch vehicle and the orbital station will be left up to the discretion of NASA, the Japanese said.

Due in 1964 . . .

Rebound May Carry Mixed Load of ComSats

New Schjeldahl design might join Echo II types; tests also begun on advanced Geophysics Corp. mesh material

by Michael Getler



GCA's Vice President Robert M. Chapman holds forth on advantages of expanded aluminum mesh for applications in satellite communications.

NASA's passive communications satellite Project *Rebound* now scheduled for a 1964 launching could carry a mixed load of satellite types into orbit.

Results of the *Echo II*, or *A-12*, rigidized passive communications satellite launching slated for late this year, and ground tests of a new advanced design satellite should determine the configuration for the first *Rebound* payload.

In *Rebound*, the space agency will attempt to launch a multiple load of passive ComSats aboard a single *Atlas-Agena* booster and disperse them in orbit to form a workable passive satellite communications network.

The *A-12* balloon, developed by the G. T. Schjeldahl Co. of Northfield, Minn., is certain to be the basis for *Rebound* pending successful flight performance later this year. However, NASA is also reportedly considering using another Schjeldahl design as part of the first *Rebound* payload in addition to the *A-12* types.

The second Schjeldahl design comes as part of NASA's advanced technology effort in inflatable structures. Both Schjeldahl and the Viron Div. of Geophysics Corp. of America are working under current space agency contracts to develop advanced techniques in this area. The Schjeldahl design is considerably further along than the GCA configuration at this time and therefore stands a chance of riding aboard Project *Rebound*.

• **Gas bag evaporation**—Both firms reportedly are pursuing designs which call for evaporation in orbit of the thin plastic gas barrier, leaving only the metallic frame of the satellite.

Removal of the vast surface area of the structure should aid considerably in reducing orbital perturbations caused by solar heating of the surface, and should also reduce thermal interaction with onboard tracking beacon equipment.

The Schjeldahl *A-12* configuration is a three-layer laminate made up of two layers of 0.18-mil aluminum foil surrounding a 0.35-mil sheet of plastic mylar.

The advanced Schjeldahl design is also a three-layer laminate somewhat similar to that of the *A-12* balloon. Scientists there are said to be experimenting with several configurations for this device, but a single configuration has been selected as most likely. It calls for two layers of 0.4 mil aluminum surrounding a 0.5 mil thickness of poly-

(Continued on page 38)

ENGINEERS GAIN A NEW PERSPECTIVE AT AC

AC, the Electronics Division of General Motors, has made a distinct contribution to technological advancement in the field of low-altitude aircraft operation. You, too, can develop and improve your career in the areas of guidance and navigation if you are an Electrical Engineer, Mechanical Engineer, Physicist or Mathematician. Current projects include: Integration and Engineering of the AN/ASQ-48 Weapon System for the B-52C&D aircraft, Inertial Guidance Systems for the Titan II, and the development of a Stellar Inertial Guidance System for advanced missiles. If you have related experience and are interested in any of the following positions, please contact Mr. G. S. Raasch, Director of Scientific and Professional Employment, Dept. 5753, 7929 South Howell, Milwaukee 1, Wisconsin.

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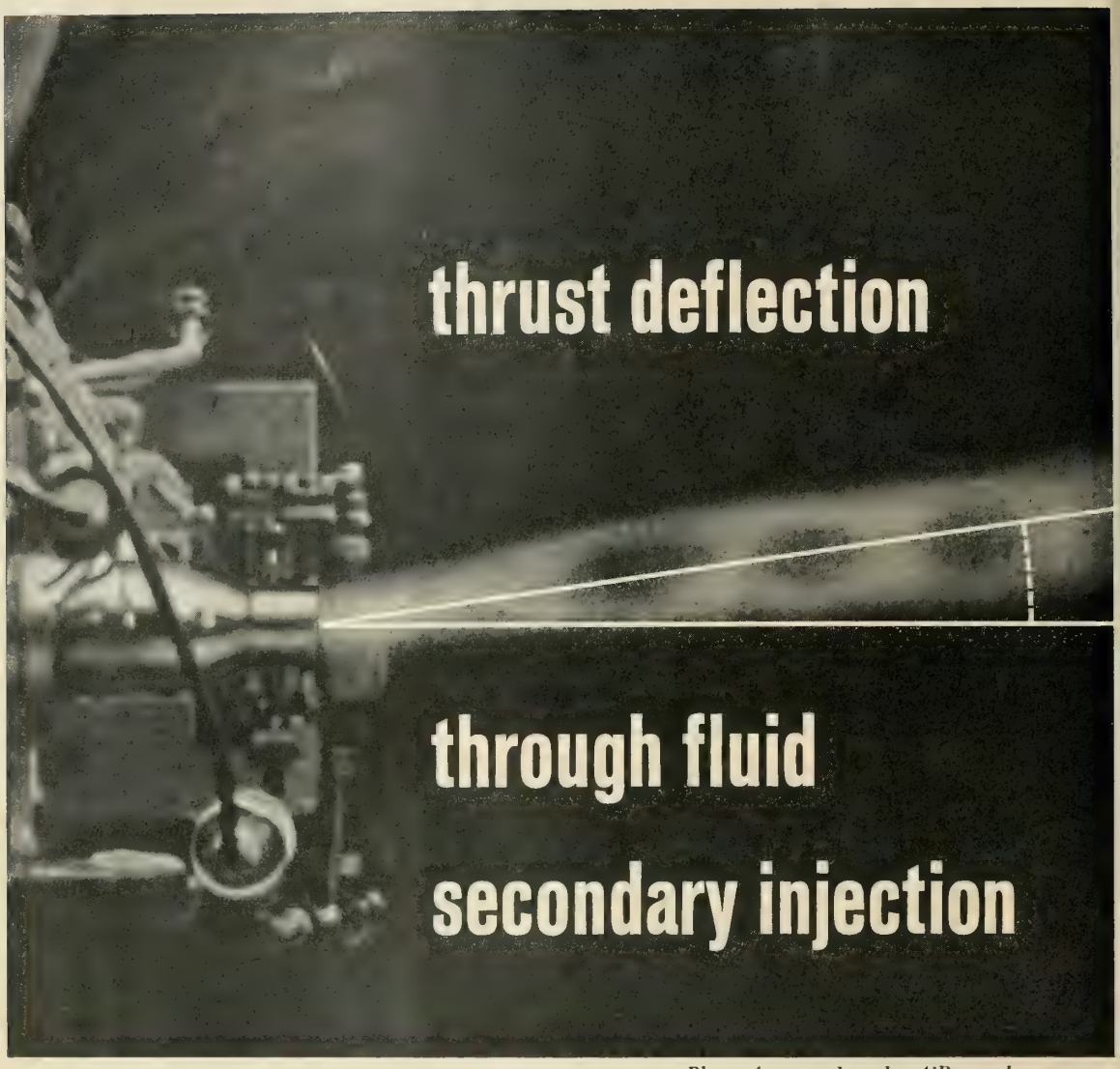


Photo of test conducted at AiResearch

AiResearch is now conducting laboratory tests utilizing various fluids in secondary injection systems for missile thrust vector control.

These tests show many advantages over present vectoring methods; faster response, moving parts are virtually eliminated, and high temperature problems are minimized. In addition, the average vectoring system weight is less as the fluid is expended at burn-out.

AiResearch, with many years of experience in systems management, research and production in the components involved, is prepared to help solve your steering and vector control problems. Direct requests for information to the Los Angeles division.

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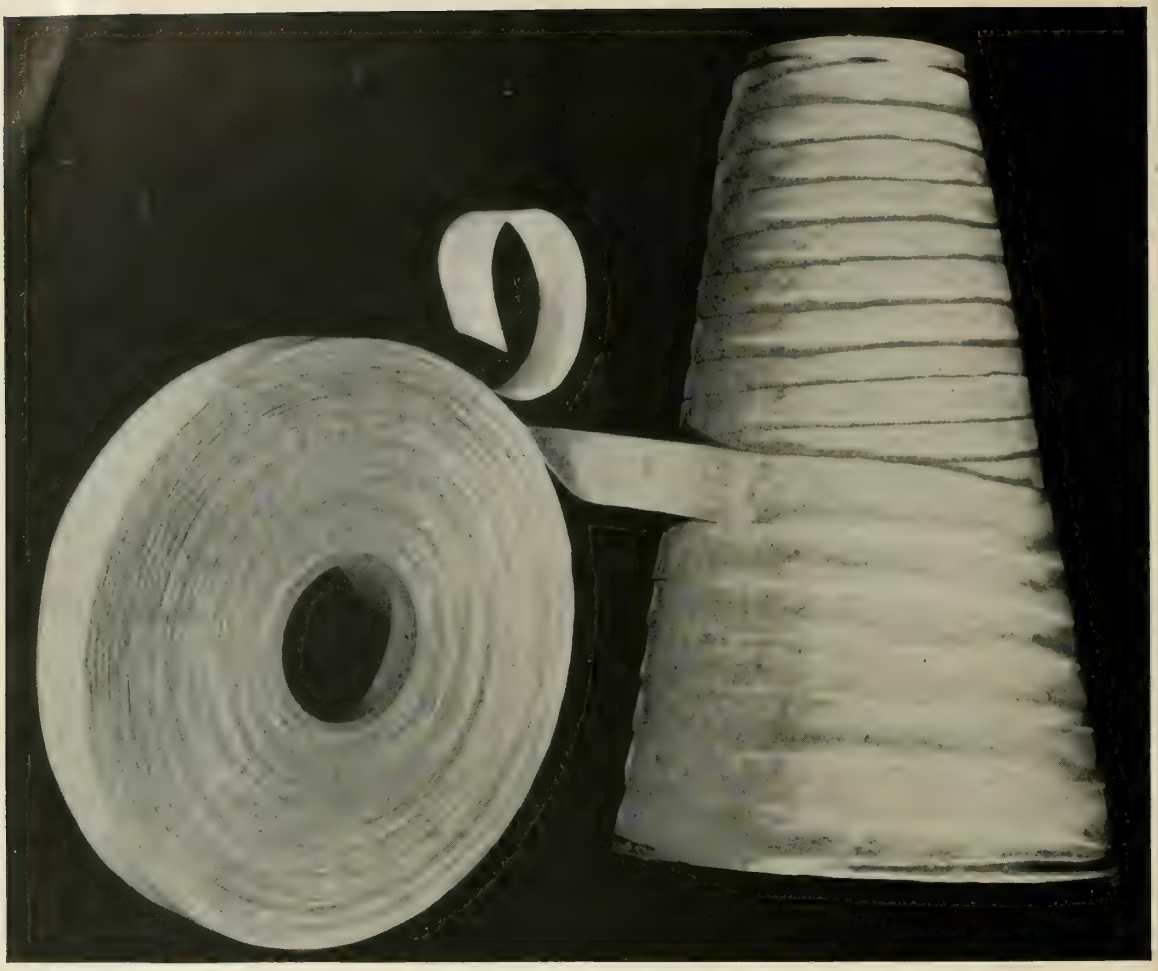
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This test-stand for large solid motors is one of the many giant-size facilities we're now building to help make our organization a second-to-none solid rocket center. The test bay is notched into one of the rugged canyons in our new 9,000-acre production and testing facility. It can handle solid rockets up to 2,000,000-lb. thrust in either horizontal or vertical position. It will be used first to test the 120-inch solid motor we are developing under research contract to the Air Force. ■ In another recent contract, Lockheed Propulsion Company was selected by North American Aviation and NASA to design and build the solid escape motor for the Apollo spacecraft.

LOCKHEED PROPULSION COMPANY

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The tape is made of 100% ASTM grade-AAAA long, oriented chrysotile asbestos fiber, saturated with a phenolic resin meeting military specifications MIL-R-9299. Flexible and tacky before curing, the partially dried tape is extremely conformable. Good fiber dispersion provides maximum and uniform reinforcement to the cured Thermomat. The unique characteristics of the tape allow easy working together of joints and permit free flow of fiber during molding. Even in intricate configurations, non-fillouts and resin-rich areas are reduced to a minimum. Molded parts can be easily machined and finished into precision units with close dimensional tolerances.

J-M Thermomat Tape is available in a variety of styles with varying resin, asbestos fiber and additive contents to allow fabrication of components for specific applications. Many Thermomat styles, for example, contain various inorganic fillers for improved thermal performance. Elastomer-modified phenolic resin styles are available for fabricating semi-rigid to highly flexible parts. J-M can also provide compositions that result in extremely low finished-part density. Though specially designed for tape winding operations, the versatility of Thermomat Tape makes it readily adaptable for hand layup, and low- to high-pressure molding, keeping inventory waste to a minimum.

The uncured tape is supplied in rolls, 1½″ wide by 0.050″ thick . . . in lengths of approximately 320 feet . . . weighing about 16 lbs. net. When stored at temperatures not exceeding 40F, it has a shelf life of up to 6 months. Molders are invited to write for Technical Bulletin Tx-14A. Write to Johns-Manville, Box 359, New York 16, N. Y. In Canada, address Port Credit, Ont. Cable: Johnmanvil.

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Technical Countdown

ELECTRONICS

Tiny IR Cooler Developed

Both the Air Force and Navy are said to be interested in a new thermoelectric cooling unit for infrared detector elements to increase sensitivity in missile guidance systems. Scientists at the Borg-Warner Corp. report development of a "thimble" size multi-stage cascaded T-E unit which has achieved temperatures of about —130°F. It has been proposed as an alternative to present liquid nitrogen coolers.

Stratoscope II May Begin With IR Study

Test results reported by Perkin-Elmer of the star tracker to be used in controlling the huge optical system in *Stratoscope II*, indicate an accuracy of better than 0.02 sec. RMS on 9th-magnitude stars. Other infrared gear is now under test. Expected to be launched at the turn of the year, the 600-ft. research balloon will carry a 6000-lb. optical payload (M/R, May 21, p. 13). A January date apparently would be more favorable for a Mars infrared study, rather than the previously planned Venus photographic mission. P-E engineers also report that fabrication goals for the complete optical system demand achieving a minimum of 90% of theoretical performance. Thus, the 36-in.-dia. primary mirror roughness limit is set at 1/40 wavelength.

Improved Speed of Light Figure Sought

Basic research aimed at using the wavelength of a laser light beam as a measurement standard to improve present calculation of the speed of light has been initiated by General Electric. GE's Defense Systems will attempt to find a way to improve light velocity measurement accuracy by 100 times (present error is estimated at 3 parts per million). Such an improvement, GE scientists assert, might obviate the need for separate terminal guidance in interplanetary flight—and thus bypass a significant weight penalty.

ARIS Radars Now Under Test

The 30-ft., 1½-ton radar dishes for the first two ARIS (Advance Range Instrumentation Ship) vessels are now being tested on Sperry Gyroscope Company's new mile-long radar range in Brookhaven Township on eastern Long Island, N.Y. The North-South range employs 30-ft. towers on two 240-ft.-high hilltops at each end. Part of a complete system called the Integrated Instrumentation Radar, it is considered the largest precision radar designed for shipboard use, says Sperry, prime contractor to Air Force for the initial ARIS program.

Miniature Transceiver Provides 4 Channels

A tiny radio transceiver weighing less than 3 ounces is being used at White Sands Missile Range for telemetering atmospheric-probe data to Army ground stations. The 1-in.-x-6-in. long unit is believed to be the smallest 4-channel radio ever designed for rocket use. It is being used in *Loki Dart* rockets to relay data on temperature, density and particle measurements, and other scientific information from altitudes of about 40 miles over the New Mexico range.

ADVANCED MATERIALS

Thin-Film Resistors Improved through Nitrogen

Bell Telephone Labs has improved tantalum thin-film resistors by sputtering in a partial nitrogen atmosphere. The technique gives resistors stability and reliability comparable to hermetically sealed devices. Small amounts of N_2 (1-10% by pressure) added to the argon atmosphere in the sputtering operation tend to override the accidental impurities normally appearing in the pure argon. Tantalum-nitride resistors vary less than 0.1 of 1% in a 1000-hour load test.

Nickel Alloys Lubricate in Vacuum

A family of self-lubricating nickel alloys has been developed by the Ilikon Corp. through powder metallurgical techniques. The alloys are special compounds of dry lubricant powders embedded in a complex metal matrix, thus eliminating the surface wear weakness of most lubricants. Both tungsten and molybdenum disulfide have been used. Prolonged exposures in chambers simulating altitudes of 1000 miles caused no significant weight losses.

High-Purity Gallium Arsenide Breakthrough

Gallium arsenide crystals grown by the Czochralski process, ranging in size from 200 to 300 grams with electron mobilities from 10,000 to 20,000 cm^2/volt sec at 77°K, will soon be in production at the Bell & Howell Research Center. Ordinary crystals contain silicon impurities which limit the electron mobilities to 3500-6000 cm^2/volt sec. The performance of many semiconductor devices increases with an increase in electron mobility.

Navy Buys Vapor Detectors

Toxic vapor detectors which continuously sample air from liquid missile storage compartments aboard ships are being manufactured by GE Light Military Electronics for BuShips. The units will sound an alarm if vapor concentrations of hydrazine fuel and nitric acid oxidizer exceed quantities less than 0.5 parts per million. The contract calls for 12 systems, 5 of which are for the British Navy.

PROPULSION

Lunar Orbit for Apollo?

Rumors persist in authoritative technical circles in Washington that North American Aviation is delaying awarding a contract for the *Apollo* lunar-landing module because the company is not yet sure how the lunar-landing job is to be done. NASA and North American are said to be taking long second looks at a Langley Field engineer's idea that the manned capsule be launched from a lunar-orbiting *Apollo* version. The concept is reportedly far cheaper than competing methods.

SPACE MEDICINE

Helium-Oxygen Atmosphere for Apollo?

NASA is closely watching Navy research on a 87 psi, helium-oxygen atmosphere for closed environments—including submarines and space vehicles. If the 97% helium, 3% oxygen mixture pans out as well as it did in preliminary animal tests, such a combination might appear as early as *Apollo*. Navy's only concern—one human subject exposed showed subtle electroencephalogram symptoms toward epilepsy. Upcoming long-duration tests will try to disprove any relationship between the tests and the subject's reaction.

Gas Gyro Tested for Use in Five

Lear's tough, small, low-cost and accurate Model 1091 believed first gas unit ever successfully flight-tested in missile

A NEW low-drift gas-driven gyroscope is being considered for use in five tactical missile systems.

So rugged is the inertial unit that after an explosive impact during a recent flight test in an antitank missile the gyro rotor was found still spinning. The test target was comparable to a heavy armor-clad tank, engineers say, and had it been an actual vehicle its destruction would have been assured.

Developed by the Instrument Division of Lear, Incorporated, in Grand Rapids, Mich., prototypes are now being tested for possible use in *Shillelagh, Tartar, Typhon, Tow,* and a new classified missile system.

Lear's Model 1091 gyro boasts small size and weight, very high angular momentum, unusually short run-up time, and low cost.

To date, the company has built and tested about 60 of the gyros, including two successful flight tests in an antitank missile.

A second-generation version now on the drawing board will include a miniature internal electric motor to achieve indefinite running time.

• **Development**—Lear has been developing its Model 1091 for more than four years to answer a universal need for a rugged, accurate, low-cost gyro for tactical weapons.

First result of the intensive effort was development of the company's Model 1090 gas-driven gyro. Called Genie, it proved the practicality of the gas-driven rotor approach. It was reliable, had relatively few parts and was capable of long-time storage, according to Lear. However, engineers felt it still wasn't the complete answer — they wanted a much smaller and lighter unit.

Thus, Genie, Jr. evolved. The 1091 is ⅙ the size of its predecessor. Measuring 3 in. long by about 2 in. in diameter, Genie, Jr. weighs less than one pound. When its tiny hot-gas charge is fired, a rotor speed of 42,000 rpm is obtained in 0.1 sec. This, developers say, is about twice the speed of the average gyro.

A two-degree-of-freedom gyro, it employs only four moving parts.

Angular momentum at the start of run-down is 0.5×10^6 gm-cm²/sec. Decay is less than 50% after 50 sec. running time.

A single electrical pulse of 0.1 watt-sec. is required to uncage the gyro and fire the pyrotechnic. Transfer of energy from the solid propellant is handled by an impulse turbine. The turbine was selected, Lear says, because tests showed that it was capable of developing twice the torque obtainable from a jet reaction wheel.

Not only was the turbine proved more efficient in using the hot-gas supply, but its balance was found to be far less critical than that of the reaction wheel.

• **Controlled burning** — The gas generator itself consists of a firing squib and a non-hygroscopic solid-propellant grain. Rate of burning is controlled, providing a constant mass flow at the nozzle. Combustion products are noncorrosive and non-toxic.

Hot gas is directed through a convergent-divergent nozzle into the turbine "buckets." The gas stream has very high velocity and relatively low pressure at the nozzle exhaust, according to designers.

For gyro evaluation and testing, the combustion chamber and uncaging mechanism are designed to permit operation from a cold-gas supply. Only an external adapter is necessary.

• **Maximum inertia** — Lear contracted with the Battelle Memorial Institute for the development of basic design information for the small turbine wheels. Maximum rotor inertia and minimum weight is accomplished by making the wheel of three pieces. The assembled wheel has an inertia of 145 gm-cm².

The symmetrical shape of the rotor makes balancing, to a high degree, a routine task; it also insures stability at maximum speeds. Wheel preloads are set to a value which guarantees that the bearing pair will not unload under severe vibration and shock. Anisoelastic drift for the selected R3 bearings will not exceed 0.15 deg/hr/g², according to design calculations.

The inner gimbal was designed to provide high environmental integrity. Since the inertia of a rotor is a function of the diameter raised to the fourth power, the outer diameter of the rotor was increased to the maximum dimension. This was accomplished by using an inner gimbal of shell construction. It offers great structural stability under load and at the same time affords ease of producibility and assembly.

The shrouding effect of the gimbal on the rotor effectively increases the operating life of the gyroscope by reducing windage torques. Tests have shown that these torques have been decreased to approximately one-half the unshrouded value, Lear says.

The outer gimbal is constructed with domed ends and curved sides to insure rigidity and to enhance vibration and shock integrity. Inner gimbal freedom is ±80°, outer gimbal is 360°.

The pickoffs are potentiometers

Genie, Jr., Test Conditions And Performance Characteristics

Environment:

Scorsby test *15° peak to peak, 6 cpm*
Acceleration *25-g along each of the principal axes*
Operating vibration *10-g, 20 to 2000 cps, 3 principal axes*
Operating shock *325-g, ¼ cosine pulse, 20 milliseconds, parallel to outer axis*
Operating temperature *−65°F to +165°F*

Performance:

Drift *(When subjected to above environmental requirements) 2° in 30 seconds max.*
Scorsby drift *1° in 30 seconds*
Storage life *5 years*
Angular momentum *at start 0.50 x 10⁶ gm-cm²/sec.*

Weapons

by Charles D. LaFond

having a resolution of 0.2 degree and a linearity of 1%.

The bearings on all axes are of instrument-quality stainless steel and are shielded.

• **Uncaging highly reliable** — The uncaging mechanism is composed of a spring-loaded snorkel and a piston-action locking pin. In the normal storage or caged condition, the snorkel mechanically holds both the inner and outer gimbals to an accuracy of less than 0.1 degree. The locking pin positively holds the snorkel in its spring-loaded cages position. When gas pressure increases to a value which is greater than the spring force, the snorkel raises slightly, allowing the locking pin to move clear of the snorkel.

When gas force acting on the snorkel area decreases to less than the spring force, the snorkel is automatically and simultaneously retracted from both gimbals, resulting in instantaneous uncaging. In several hundred tests of the uncaging system there has never been a failure to uncage, nor have repeated shock and vibration tests caused a premature uncaging, Lear asserts.

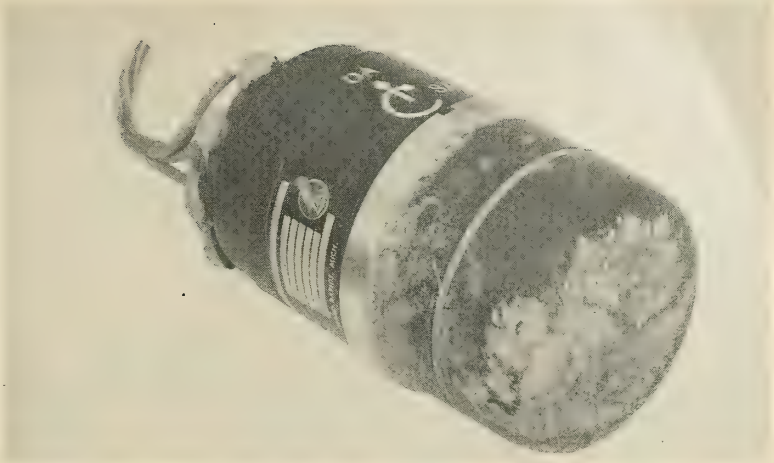
So far, 77 gyro tests have been performed by Lear for its use in *Shillelagh* alone; all were duplicated later by Aeronutronic Div. of Ford Motor Co., prime contractor for the missile.

The test environments and performance results claimed for the 1091 are shown in the accompanying table.

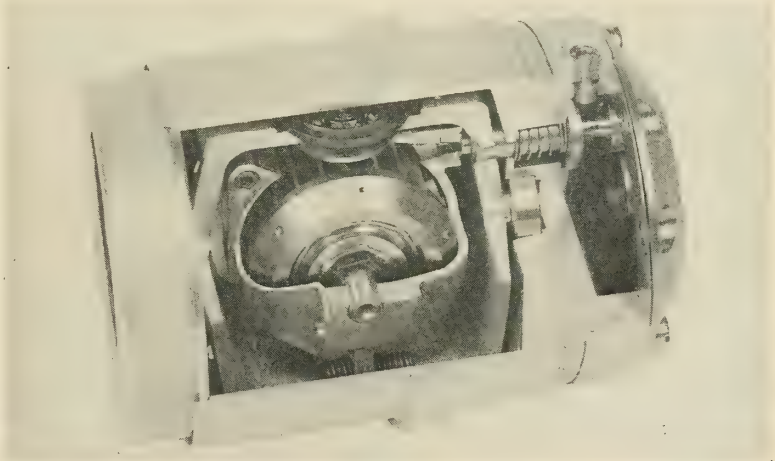
Lear believes its new model is the first gas gyro ever missile-flight-tested successfully.

The company estimates unit reliability at 99.6, based on long-time testing in its own labs and by potential users. Drift rate for Genie, Jr., has been determined to be less than 0.5°/min. under normal operating conditions.

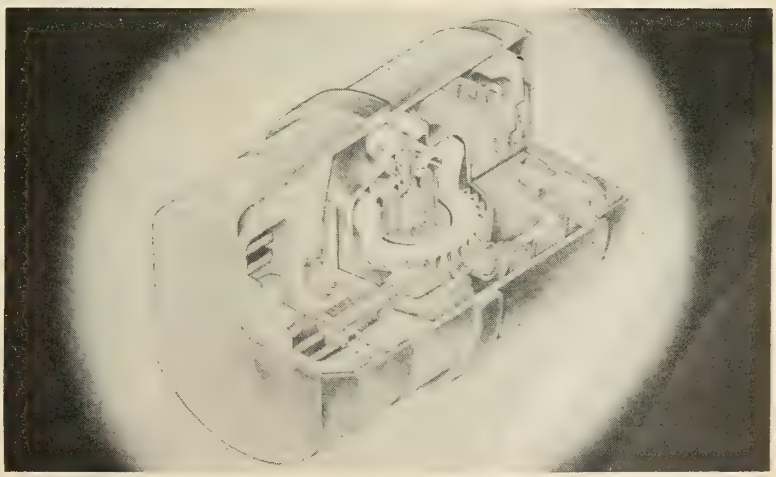
With the successful inclusion of an electric motor to permit instantaneous readiness, and if the gyro performance characteristics of Lear's new inertial unit are maintained, the potential in the missile field appears to be extremely broad. ⌘



GENIE, JR., GAS GYRO is shown after it was recovered from a tactical missile firing into a simulated armored vehicle. The gyro was still running when retrieved after impact. The two-degree-of-freedom gyro measures roughly 3 in. x 2 in. diam., and has a drift rate of less than 0.5°/min.



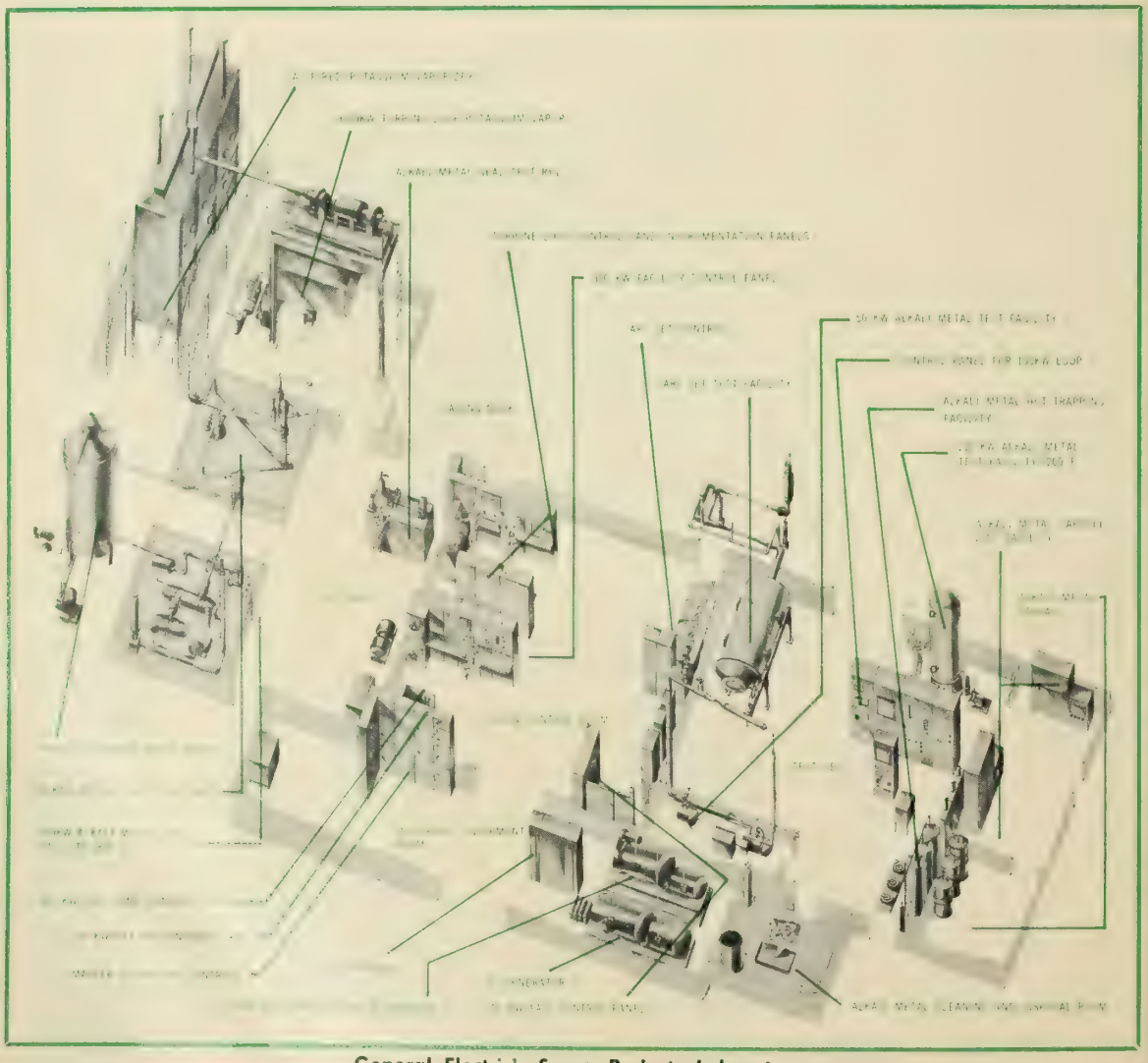
CUTAWAY VIEWS of Model 1091 Genie, Jr. (above) and artist's conception of Model 1092 (below). Addition of an electric motor to sustain angular momentum in the proposed model will increase weight to 1 lb., add only 0.1 in. to overall length, and result in a gyro that Lear estimates will cost only one-fifth as much as any comparable electrically driven unit.



GE Liquid Metal Loops in Operation

Huge facility aimed at collecting data for space nuclear power will boil and condense liquid metals up to 1800°F

by John F. Judge



General Electric's Space Projects Laboratory

CINCINNATI—The complex task of gathering design data for spacecraft nuclear power-plants is under way at General Electric's Space Power and Propulsion section, with the operation of a new 300-kw liquid metal boiling and condensing test facility.

The test loops were designed by GE to study the heat-transfer characteristics of several liquid metal working fluids as part of a National Aeronautics and Space Administration contract.

The firm has been working on high-powered nuclear turbogenerator systems for over four years. The space power systems are designed to use heat energy generated by a nuclear reactor to vaporize liquid alkali metals such as potassium or sodium. The vapor then powers a turbine which drives an electrical generator.

The heart of the problem for designers of such systems lies in understanding the heat-transfer mechanisms involved and their effect on the materials to be used.

For instance, it is impossible to design a boiler or a condenser until fundamental heat-transfer data are available—and liquid metal loops are the only tools capable of providing these basic answers.

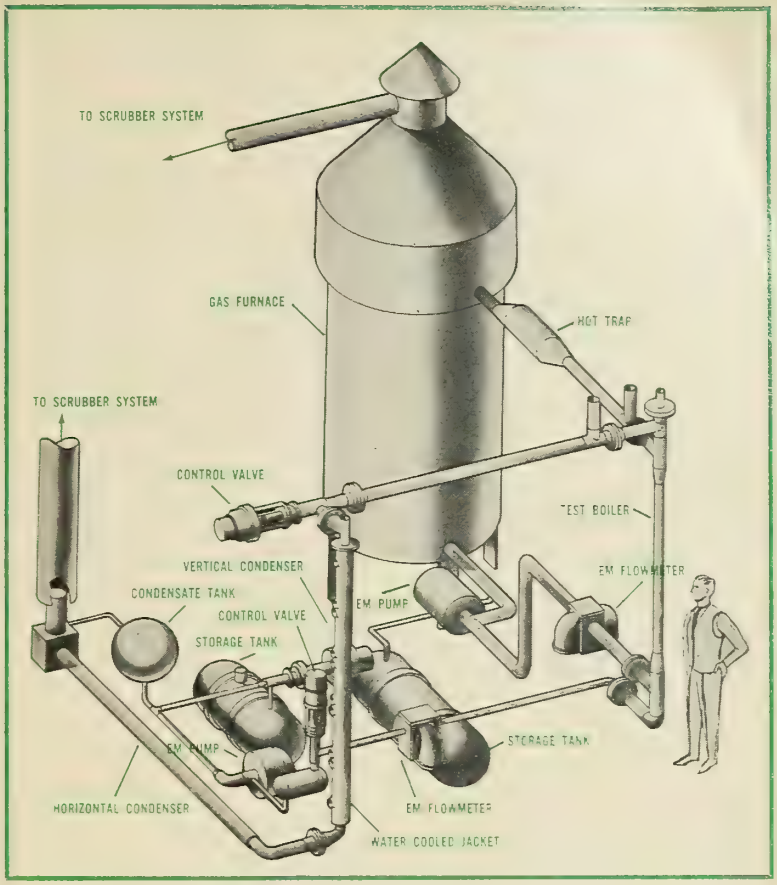
• **Two-phase test** — The $350,000 test unit is really two separate loops—a primary loop which carries heat to a boiler test section and a secondary loop which picks up this heat in the boiler area and transfers it to a second liquid metal.

The complex is capable of continuous operation at temperatures up to 1850°F and, since the liquid metals are highly corrosive at these heat levels, it is constructed entirely from a tough cobalt-base alloy produced by Haynes Stellite.

Different working fluids can be tested in the two loops simultaneously. The primary loop can handle flow rates greater than 200 gal./min. with a pressure rise of 20 psi. The secondary loop can operate at 30 gal./min. with a pressure rise of 30 psi when the alkali metal is in the liquid state, or at 3.5 gal./min. with a pressure rise of 100 psi when the metal is vaporized.

The entire 300-kw system is suspended from constant load cells to handle the various movements generated when the facility is running. Besides the heat-transfer data, the loop will supply information on the compatibility of materials.

In itself, the loop has inherent problems. There is a possibility the constituent loop alloys might suffer a loss of ductility with time. How serious this problem will be is unknown. Periodically taking the system to the high temperatures involved tends to stress-relieve the alloy.



300-KW two-loop liquid metal boiling and condensing facility.

The vertical condenser test section in the system is subdivided into three sections—allowing GE specialists to treat each condensing condition separately.

The two-phase loop is operated and monitored from an adjacent control and data recording center.

The 300-kw facility is designed to simulate many of the characteristics of a nuclear turbogenerator systems. It is reported to be the largest such facility in the U.S. Sodium and potassium will be the main liquid metals studied.

• **Power complex**—GE is in the process of constructing an integrated space power laboratory devoted to the entire problem area of liquid metal handling and application. Besides the 300-kw two-phase system, the firm is building a liquid metal loop which will be capable of 2200°F operation in a 10^{-9} mm. Hg. vacuum chamber.

This particular system will be the only one of its kind—designed to check out the characteristics of liquid metals operating in a situation simulating a space vacuum as closely as possible.

The vacuum loop proved to be a major exercise in the welding of refractory metals.

GE power specialists believe that vacuum simulation is the only way to obtain meaningful data. The chamber is rated at 10^{-9} mm. Hg., but it is expected that in actual test runs the vacuum will be held around 10^{-8} mm. Hg.

There are also plans for a facility for testing full-scale, high-speed turbines. Two stages of a full turbine for liquid metal applications will be included. The completion date is scheduled for September.

General Electric considers space power an extension of its basic business. The nuclear generation of electrical power in space is intimately tied to a number of programs, but the principal technology which is highly dependent upon progress in this area is electrical propulsion.

The firm's experience in jet engines and the allied materials problems provides a broad operating base. The Space Power Laboratory is only the first step to actual hardware development. A huge amount of basic and applied research remains to be accomplished before this becomes reality. ⁂





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Systems Manager for the Navy POLARIS FBM and the Air Force AGENA Satellite in the DISCOVERER and MIDAS programs. Other current programs include SAINT, ADVENT and such NASA projects as OGO, OAO, ECHO, and NIMBUS.

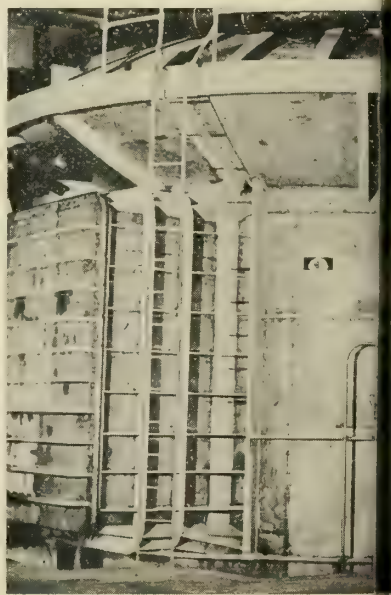
SUNNYVALE, PALO ALTO, VAN NUYS, SANTA CRUZ, SANTA MARIA, CALIFORNIA • CAPE CANAVERAL, FLORIDA • HAWAII

Chamber Tops Design Specs

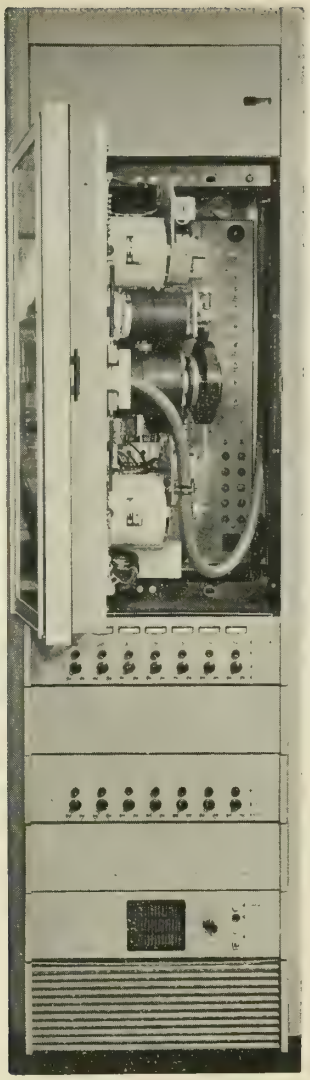
THE HUGE SPACE simulation chamber at Grumman Aircraft Engineering Corp. is exceeding its design specifications for ultrahigh vacuum through a 30% increase in its diffusion pumping speed.

Specifications for vacuum on the system were 200 microns or 0.2 torr in 1 hour, 5×10^{-6} torr in 8 hours and 1×10^{-7} torr in 16 hours. At 10^{-7} torr, specs called for pumping of nitrogen at 70,000 liters/sec. Performance has been considerably better—6×10^{-9} torr was reached in 6 hours and nitrogen pump speed of 175,000 liters/sec. at 10^{-7} torr.

NRC Equipment Corp. built the complete chamber pumping system and the controls for Chicago Bridge & Iron



LARGEST space simulation chamber in the U.S. capable of operating in the 6 x 10^{-9} range has exceeded design specifications at Grumman. The hemispheric



Look in on 7 channels of

Inside this new, 7-channel, VR-3600 Magnetic Tape Recorder/Reproducer by CEC is circuitry that meets the toughest of specs – and simultaneously records predetected and postdetected data. A completely integrated system, its skew is under ±0.30 μsec; intermodulation distortion, under 0.75%; flutter, less than 0.10% at 120 ips. And a 1.0 μsec. phase response on the low pass channels permits faithful reproduction of transient information. It has 4 predetection and 3 postdetection channels and 3 operating speeds (30 to 120 ips.). The VR-3600 is packaged in this single cabinet, thanks to compact styling and use of solid-state electronics – plug-in record and reproduce amplifiers with printed circuit epoxy boards. Tape transport and electronics are placed to insure maximum operator efficiency. ⋙→

Circle No. 9 on Subscriber Service Card

Co., prime contractor for the facility.

• **Design responsible** — The net pumping speed is much higher than would be expected for the number of pumps used, thanks to the design of the drum-shaped cold traps, which provide a minimum resistance to pumped gas yet effectively prevent oil contamination.

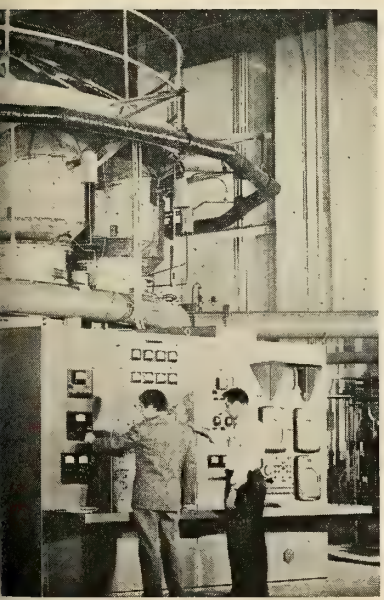
This was accomplished by making the cold trap larger than the exit and providing a set of copper blocking rings —offering a minimum resistance to passage of gas molecules.

A second factor in the increased pump speed is that the eight 32-in. diffusion pumps are connected to a peripheral bulge on the chamber, rather than being conventionally mounted by individual ports. The bulge approach eliminated the restricting effect on gas flow caused by individual ports connections, and permitted the gas to flow over a larger area of the chamber wall.

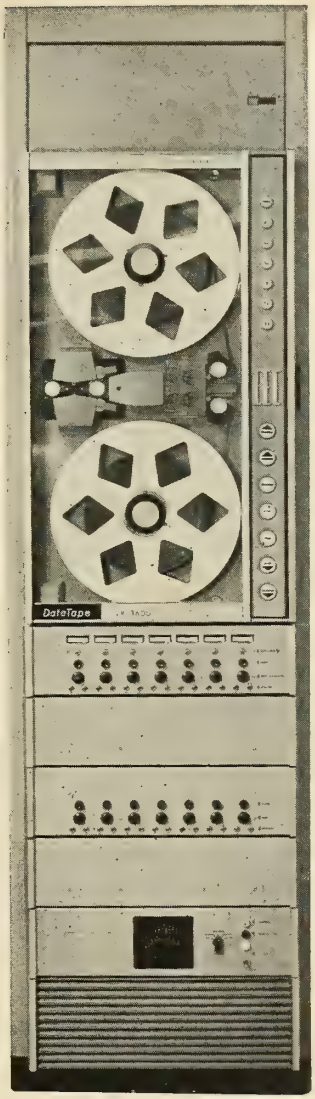
The vast test chamber, capable of simulating an altitude of 250 miles, will be used by Grumman for its *Orbiting Astronomical Observatory* and for other satellites and spacecraft.

The stainless steel chamber is 19 ft. in diameter and 26 ft. long. Radiation and temperature variations will be simulated along with the vacuum in the 8500-cu.-ft. facility.

The unbaked chamber has an inner shell lined with a blackened heat sink to realistically determine the satellite and component temperatures. Closed-circuit TV is used for viewing test operations. ⌘



bulge around the top connected to the large diffusion pumps is one of the reasons for the unplanned increase in pumping speeds.



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Lockheed Thinks Big in Propulsion

Firm may invest as much as $40 million, is confident of qualifications for big solids

by Willard E. Wilks

REDLANDS, CALIF.—Lockheed Aircraft Corp., which acquired full ownership of the lagging Grand Central Rocket Co. 10 months ago, embarked on a $40-million drive to "build it into something as big as Aerojet or Thiokol."

Now concentrating its effort on large solids, Lockheed, which first acquired part interest in GCR more than two years ago, has its eye on other areas as well—including hybrids, storable liquids and high-performance solids.

Larry Thackwell, senior vice president-Advanced Concepts of the new Lockheed Propulsion Co., told M/R: "This is a case of a giant company which knows the overall aerospace business boring in on a *component*—propulsion. Lockheed is doing it with a lot of thought behind it, a detailed plan, a belief in the future and a determination to make this thing succeed."

Disappointed in its first crack at the big game, the 120-in. *Titan III* booster job won by United Technology Corp., LPC now is going ahead with competition for the 156-in. motor and gearing for the 240-in.

• **Big booster assets**—LPC President Robert F. Hurt said Lockheed has invested or committed more than $20 million to date and plans—if all goes well—to spend another $20 million for expansion and "seeding" over the next 5-6 years. He listed these reasons why "we think we can get into the large motor business."

—LPC has fired the largest solid motor yet produced in this country, the Air Force 120-in. applied research motor (ARM). This motor, on which the firm had based high hopes for the *Titan III* award, was developed ahead of its schedule.

—It has opened a new 9100-acre facility—in sheer acreage perhaps the nation's largest site designed solely for production of big solids. The facility is equipped with a 2-million-lb.-thrust test stand and a nondestructive test unit which includes a new 25 million-electron volt betatron.

—In its propellant work it has demonstrated the highest I_{sp} among standard solids in industry, says Thackwell. "We are 'way in the lead there,'" he asserts.

—Its Polycarbutene-R propellant has in tests withstood a temperature environment of −65 to 165°F., "meeting and in some cases exceeding Air Force requirements," George S. Cushman, vice president-operations, reports.

• **Unique 120-incher**—LPC fired the 120-in. ARM at its new Potrero, Calif., site on May 12. Built in three jointed sections, the 200,000-lb. motor containing more than 160,000 lbs. of propellant burned for 132 sec., producing 400,000 lbs. of thrust.

The 120-in. firing was carried out mainly to test two Air Force thrust-vector control (TVC) systems using secondary fluid injection, although the Air Force also wanted to demonstrate firing of another large solid. More than 100 experimental fluid injections were conducted during the firing.

Lockheed, as prime contractor and weapon system manager for *Polaris*, claims more experience than anyone else with TVC—"we have been the only ones to put TVC on a missile in free flight, the second stage of *Polaris*."

The 120-in. motor has several features Lockheed believes to be "unique." Details are classified, but these innovations are known to include a low-weight clevis joint design using tapered pins, the Polycarbutene propellant and a simple grain design.

"The grain design eliminates the stress concentration resulting from the usual star-shaped configuration, which we didn't use," LPC said. "While design of the 120-in. motor was not dependent upon high I_{sp}—the Air Force requiring that we stay within the state of the art—that obtained is better than average."

• **200% upswing**—Hurt, a 12-year Lockheed veteran who moved to his



LPC PRESIDENT Robert F. Hurt (left) makes a point during discussion with Rep. James C. Corman (D-Calif.) in Washington, D.C., recently.

new job shortly after LAC acquired full ownership of LPC last August, said that in getting technically equipped "we went ahead and funded facilities to perform contracts we wouldn't have gotten otherwise.

"For instance, the 120-in. motor required four major items we didn't have—mixing, casting and curing, nondestructive test and test stand facilities. The value of the facilities we put in is more than the value of the contract. But we felt that, with the potential for follow-on work, this was good business."

This approach and a more aggressive sales effort has resulted in an almost 200% increase in business in the past five months, Hurt says. New business has included Air Force support on the 120-in. motor, a $5-million contract for the *Apollo* launch escape rocket, and an award from General Dynamics for Phase 3 work on the Army's *Mauler*.

Hurt and Vice President-Administration James H. Brown point out, however, that LPC business is rising from a low point because GCR, prior to its acquisition by Lockheed, had suffered a serious drop due to phasing out of *Nike-Zeus* work.

"This meant we had to go through a period of readjustment," Brown says, "but we got a valuable by-product out of it—we trimmed unnecessary functions, consolidated where possible and came up with a lean, hard-running outfit."

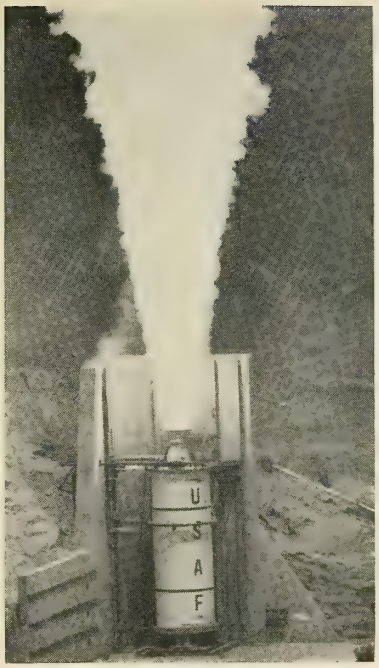
• **Solid background**—The company has been involved in a number of facets of the big solid program for about three years, including system optimization studies of applications for space purposes under a contract from National Aeronautics and Space Administration.

G. R. Makepeace, Vice President-Research and Engineering, considers this work of great importance to the reputation LPC is striving to achieve. "We found many basic parameters which have become accepted by us and pretty much by the services as the basics of what a large solid should be. It is out of such studies by us and other companies that the basic segmented concept and clustering, staging and economic considerations of large boosters have developed."

Studies have included Air Force-supported work in which LPC conducted subscale research into segmented joint design and thrust vector control using secondary fluid injection.

The company claims to be a front-runner in its work on hybrid motors, hot gas TVC, high mass-ratio motors for upper stages and solid-propellant research.

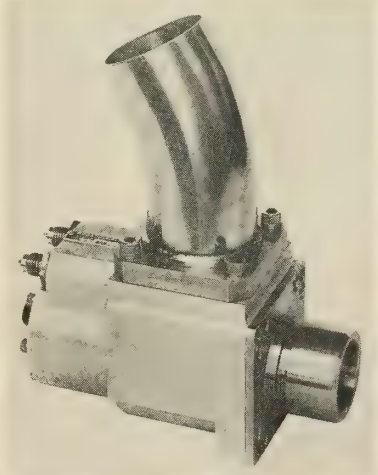
Thackwell and Makepeace believe the hybrid motor "could easily be the ultimate in chemical propulsion for manned space vehicles."



LARGEST solid motor yet produced in the U.S. was successfully fired by Lockheed on May 12, burning for 132 sec. and producing 400,000 lbs. of thrust.

• **High hopes for hybrids**—According to Thackwell, LPC achieved practical large hybrid motors earlier than anyone else with firing of a 19-in. model for 30-40 sec. duration about four months ago.

"We believe, using a liquid oxidant and solid fuel, precise control of the hybrid will be easier to attain than with any kind of liquid," says Thackwell.



CLOSEUP of variable area injectant valve used in LPC's May 12 firing. Valve was developed by Moog Servocontrols, Inc., of East Aurora, N.Y.

"On the basis of our tests so far, it looks like an open and shut case for the hybrid—you open and shut the valve and that's it."

While there has been little support from the services for hybrids until recently, Thackwell sees "quite a storm of interest developing," with hybrids coming into use as large boosters of the second generation.

Much of LPC's hybrid work is in-house, but it has support from NASA, Air Force and Army. In a study partly funded by NASA, it is looking at hybrids for both manned and unmanned lunar operations. Aim is to determine what would be needed for a firm development program and how hybrids compare with storable liquids. The company is also working with NASA's Jet Propulsion Laboratory on a similar study of solid motor applications to lunar and interplanetary missions.

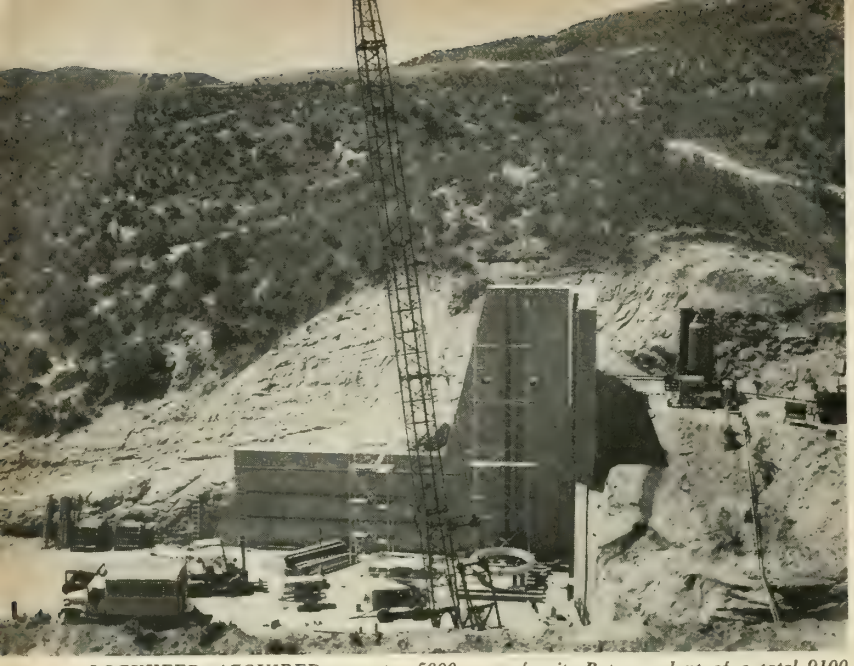
Makepeace, who says LPC has been working within a hybrid I_{sp} range of 250-310 sec., believes hybrids may get a big boost from the fact that "we might very well see extremely high-performance ingredients in the hybrid before we are able to formulate them into solid motors."

• **TVC**—Partly as an outgrowth of its work on hybrids, LPC has done considerable research into TVC with partial Air Force funding. It has been investigating both inert and reactive liquids and advanced methods of generating hot gas for TVC. On the basis of analysis, it thinks its approach demonstrates the highest performance to date. The 120-in. motor used TVC systems required by the Air Force, not Lockheed's.

High mass-ratio work was started when GCR developed the original top stage for *Vanguard*. Since then the company has conducted several NASA studies and worked on some sizable experimental contracts to develop top stages of extremely high mass-ratio. Results are classified, but one of LPC's designs has "a higher mass-ratio than an egg."

• **Fuels**—The company has developed two solid propellants in the polycarbutene and nitroplastisol families, and "has evidence to believe that we are leading when you consider cost, performance, application, safety and logistics." Polycarbutene-R, basically a carboxylated polybutadine acrylic acid cured with advanced chemicals which impart very superior mechanical characteristics, and nitroplastisol, a composite nitrocellulose base produced by a plastisol process, both are easy and safe to manufacture by LPC processes. Lockheed will use the polycarbutenes for very large motors and workhorse applications of all kinds.

In addition, LPC has devoted a



LOCKHEED ACQUIRED an extra 5000 acres for its Potrero plant of a total 9100 acres. In three months, installation grew from ground-breaking to facilities stage.

great deal of study to structural integrity of propellants with partial Army and Air Force support. "We have developed refined techniques which enable precision prediction of what propellant physical properties are required to meet specifications of any given rocket motor," says Makepeace. "This has become a science instead of a black art. We may very well be the leader here."

• **The plan**—Makepeace is the executive responsible for the $20-million expansion and seeding plan with which LPC hopes to climb to the top in the propulsion business. He began evolving the plan several years ago when GCR, while it "had come a long way, had not really fully matured into the sophisticated field of modern large motors and missile systems, and had neither the facilities, personnel nor technical capabilities.

"This money is spent or committed to be spent in case we get the right kind of contracts," Makepeace says. "In order to keep growing, we've got to have, first, a first-rate program for development of our technical capabilities; secondly, the right kind of people, which you can't get without steady support, and, finally, to get anywhere, we've got to have a continuing level of financial support to pay for all this.

"Using this money, each year we identify those areas in which we need progress the most. We set up specific company-sponsored programs in those areas, and either assign or recruit the needed people. Then we carry on the work until it reaches the stage of interest where it can get support from one of the services."

Under the plan, the company has built a new propellent laboratory, a quality control lab, an instruments standards lab, a structural integrity lab and a hybrid development facility. It has equipped test stands with up-to-date digital data equipment and completely refurbished the manufacturing plant with modern mixers.

"This is the sort of pump priming operation that must go on continuously. By doing this we have built up our support from the services to something over $2 million a year now. These are small contracts, but they are damned important because the future comes out of them."

• **GCR experience** — While Lockheed has brought what Hurt calls a new look to the propulsion company, he points out that LPC is building on a base provided by GCR. It thus counts in its background of experience advanced state-of-the-art work on large solids with development of the *Nike-Zeus* sustainer, and development of the Project *Mercury* escape rocket, *Mauler* solid motors, MG-18 high mass-ratio motors, third stage motors for *Bold Orion*, motors for the upper two stages of *Farside*, and separation rockets for *Titan*.

Founded as the rocket division of Grand Central Aircraft in 1951, GCR's early work included manufacture of *Loki* rockets for the Army, development on *Dart*, and work on *Falcon*, XM-25 Jato and motors for the X-75 *Asp*.

In 1958, Tennessee Gas Transmission Co. acquired the majority interest in GCR and transferred its controlling interest to Petro-Tex Chemical Corp., jointly owned by Tennessee Gas and Food Machinery and Chemical Corp. Lockheed entered the picture as a joint owner in early 1960.

Despite ownership by three large companies involved in areas that offered valuable inputs to GCR, the firm lagged, as was evident when Lockheed acquired full ownership. Direction by three masters meant not only unwieldy control through three boards of directors, but differences in management philosophy, as indicated by Hurt:

"In this business, because of its rapidly changing aspects, you must have the ability to make decisions in a hurry. The aerospace business is based on the ability to be visonary in outlook and estimate of what is to come. You must have this when you can't see figures in black and white. In order to get into the large motor business, we first had to have a technical capability, which the company had. We then needed a facilities plan and had to be able to commit for facilities expansion in a timely manner."

• **Build-up at Potrero** — Under Lockheed direction LPC pushed development of the 120-in. motor on its own, picked up Air Force support last fall and completed the program in just 10 months. Development of the 9100-acre Potrero facility, for which 5000 additional acres were acquired, has moved from the bare ground to the facilities stage in just three months.

LPC, subcontractor to General Dynamics/Pomona for *Mauler* propellant, will install the production facilities at the Potrero site. It also has agreed to make land available to General Dynamics at the new site for *Mauler* assembly facilities.

Another smaller solid program also is expected to be located at Potrero, according to Burt C. Monesmith, Group VP, Lockheed Aircraft Corp., who observed that "there's often more money in the smaller things. They have a longer life."

While LPC could produce 240-in. motors at Potrero, it wouldn't expect to in great number because of the impossibilty of hauling such sizes from the remote location. If Lockheed was to receive a contract to produce numbers of the very large motors, Monesmith said, the company would have to set up an East Coast facility.

"Program management gives me day-to-day surveillance of what is going on," says Hurt. "The program management and master scheduling people report direct to the president, a typical Lockheed management technique." Hurt, a graduate engineer who became involved in the operations end of the business, believes it necessary that "anyone who runs this kind of business has a real appreciation for engineering and science, but at the same time a down-

(Continued on page 50)

The Industry Week

International News Briefs

Canadian Bristol-Aerojet Ltd. will be formed in Winnipeg, Canada, to produce solid rocket propellants. The company will be a jointly-owned subsidiary of Aerojet-General and Bristol Aeroplane Co. of Canada, Ltd. Arrangements have been made to acquire land for a $2-million production facility, scheduled to be in operation in 1963. Propellant produced at the plant will be used for missile and rocket programs of the Canadian Government and for joint Canadian-American projects. . . . *The Japanese Defense Agency selected United Aircraft's Sikorsky HSS-2 helicopter for its new ASW weapons system.* . . . Ether-Haydon Ltd. will be formed in Great Britain to manufacture timing motors and time controls developed by General Time Corp.'s Haydon Div. The company will be a joint venture of General Time and Ether Limited. . . . *Armour Research Foundation of Illinois Institute of Technology is expanding its international operations with a new service to help small businesses penetrate the area of foreign exporting, and to aid larger industries in establishing foreign bases of operation.* . . . California Computer Products, Inc., Downey, Calif., and Comptoirs Imex-France entered an agreement under which the French firm will represent CalComp in France for marketing digital plotters and plotter systems.

New Industry Facilities

Ets-Hokin & Galvan, Inc., opened a new 6000-sq.-ft. facility and office in Houston, Tex., to serve various NASA complexes planned in the area and NASA static test facilities in Mississippi. Co-managers of the electro-mechanical engineering and construction firm's new division are J. E. Bush and R. P. Bridgers. . . . *Space General Corp. occupied the first building of its new space center in El Monte, Calif. The administration and engineering structure will house personnel and labs previously located in Glendale and Azusa, Calif.* . . . Pacific Automation Products, Inc., expanded its Florida Division's Cocoa Beach facilities. A new 10,000-sq.-ft. building will house cryogenic and electronic engineering and manufacturing personnel. An area is set up to accommodate fabrication of custom cable assemblies and missile cable harnesses. . . . *H. I. Thompson Fiber Glass Co. established a new plant in Atlanta to produce high-temperature and acoustical insulation for missile and jet aircraft uses.* . . . American Electronic Laboratories, Inc., began construction of a new plant near Lansdale, Pa. . . . *System Development Corp. dedicated its new divisional headquarters in Lexington, Mass. The 50,000-sq.-ft. facility will house Command Control Div. headquarters.* . . . Western Semiconductors, Inc. broke ground for a new plant and headquarters in Santa Ana, Calif., which will consolidate operations under one roof. . . . *Antenna Systems, Inc., Hingham, Mass., is building a new facility in Manchester, N.H., to house corporate headquarters, engineering offices and additional manufacturing space.* . . . The Sheffield Corp. is building a $1.25 million addition to its main plant in Dayton, Ohio, to house the Autometrology Section that designs and builds automatic gaging and segregating machines, X-ray thickness gages and controls, and automatic assembly machines. . . . *Resdel Engineering Corp., Pasadena, Calif., is building a new manufacturing facility to produce electronic equipment for satellite and missile tracking communications systems.* . . . OPTOmechanisms, Inc., manufacturers of precision optical, electronic, and data processing and display equipment, occupied new facilities in Plainview, N.Y. . . . *Ampex Corp. will break ground for the first stage in a $5-million plan to improve and expand its Redwood City, Calif., facilities.* . . . North American Aviation opened its Princeton, W.Va., plant, which is producing components for the Minuteman ICBM. . . . *Western Scientific Instrument Co. opened a commercial primary standards lab in Los Angeles. The company specializes in calibration, maintenance, and repair of electronic test equipment.*

News of Mergers and Acquisitions

Wayne-George Corp., manufacturers of digital transducers, purchased Dunn Engineering Corp., Cambridge, Mass., makers of air bearing turntables and test equipment for gyro and inertial component testing. . . . *United ElectroDynamics, Inc., Pasadena, acquired Research Instruments Corp. and its Analytic Systems, Co. division. Acquisition pends final approval by the California Corporations Commissioner. ASC designs, develops, manufactures and distributes process stream analyzers and analysis systems.* . . . Illinois Tool Works Inc., Chicago, purchased Eclipse Counterbore Co., Detroit. . . . *Maxson Electronics Corp. acquired Electronic Designs, Inc., Dallas, Tex., manufacturer of test instruments.* . . . Arnold Magnetics Corp., Los Angeles, merged with Sonitherm Co., Inc., Monterey Park, Calif. . . . *Rosegold Beryllium Corp. acquired Micromodular Components, Inc., former division of Ling-Temco-Vought, Inc. MC is a specialist in the field of modular miniaturization using welded techniques.* . . . Bulova Watch Company's Keystone Controls Corp. acquired the Keystone Electronics Co., Newark, N.J.

Corporate Division Changes

Douglas Aircraft Co. established an Aircomb division to manufacture Aircomb, a phenolic kraft-paper honeycomb core material used in fabrication of missiles, space vehicles, ground support equipment and other uses. . . . *General Precision, Inc. formed a Scientific Advisory Group to guide basic and applied research of GPI in advanced fields of science and engineering and encourage development of new products.*

Coating problems on launcher arms, launchers, flame deflectors, flame buckets



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Rebound May Carry Mixed ComSats

(Continued from page 18)

ethylene. Though the net thickness of this device is greater than both the GCA material and the *A-12*, the weight is reduced through a chemical milling process performed right after lamination which mills about 70% of the aluminum, leaving hexagonal shaped holes in the aluminum layers.

The big question is will the polyethylene evaporate after inflation in orbit, and if so how long will the process take. NASA scientists on the project admit there are no certainties on this aspect of the program to date.

Full-scale, 135-ft. versions of this balloon are slated for static inflation tests at Weeksville, N.C. late this year, possibly in November. Favorable results of the ground tests could put this structure in the Project *Rebound* payload.

• **GCA design also promising**—According to NASA project scientists, the GCA design, though not quite as far along as the Schjeldahl contract, also shows considerable promise. Here again, there is concern over the performance of the evaporative substance, in this case polypropylene.

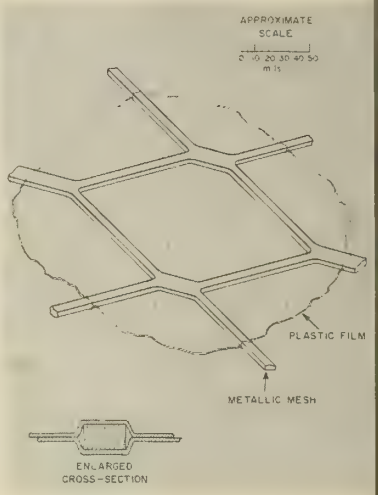
Environmental tests are under way at Wright-Patterson AFB on small, spherical models of the GCA structures, which are made of an expanded aluminum mesh laminated between two sheets of 0.2-mil polypropylene. The mesh is machined out of a single sheet of aluminum and is 0.2 thick and about 2.0 mil wide.

The models now being tested range in diameter from 3 to 20 feet.

According to Robert M. Chapman, GCA vice-president and manager of the Viron Div. at Anoka, Minn., though the test models are spherical, the space agency will evaluate the expanded aluminum mesh design for eventual use in non-spherical rigidized passive communications satellites which could reach twice the size of the *Echo I* balloon now in orbit.

For this type of mission, Chapman reports the polypropylene covering, which acts as a gas barrier during inflation, will be burned away by solar action moments after the satellite is inflated in orbit. This will leave only the expanded aluminum mesh frame which Chapman says is some 50 times more rigid than inflatables which use aluminized mylar coverings.

Chapman reports the new material will weigh less than 1 lb. per 200 sq. ft. and offers a considerable gain in radar reflectivities through exposure of both the inner and outer shell of the frame. In earlier AF tests, Chapman



EXPANDED VIEW of fabric being developed by the Viron Div. of Geophysics Corp. of American under contract from NASA's Goddard Space Flight Center. The aluminum mesh is laminated between two sheets of 0.2-mil polypropylene.

reports radar reflectivities in excess of 100% were observed due to a curious phenomenon in which reflectivity in the back-scatter region reach 7 db gain over a perfect sphere.

Though polypropylene is considered a favorable material for the particular satellite role by GCA, scientists are also experimenting with polypropylene terephthalate and with different film thicknesses and seam constructions. They are also fabricating both diamond and hexagonal shaped designs for the mesh and are using various treated aluminum alloys.

The current testing at Wright-Patterson is of the smaller diameter spheres in a 16 ft. vacuum chamber. Next month, the 20 ft. versions are expected to undergo similar tests at the 60 ft. diameter chamber at NASA's Langley Research Center.

In addition to the communications satellite role being studied, scientists at Viron see several other applications for their design including use in re-entry density measurement vehicles, as airborne radar parabolas, and as solar collectors with thermionic conversion devices.

In particular, they note the high reflectivity exhibited by this material would remove the need for mounting corner reflectors in re-entry density test vehicles and similar experiments which require ground tracking. ⌗



ENGINEERS AT ASTRONAUTICS 'ORBIT THE EARTH'

In this mockup model of "MARS"—Manned Astronautical Research Station—engineers are making simulated space flights at General Dynamics | Astronautics in San Diego, California.

The MARS vehicle, placed in orbit by Atlas-Centaur (also designed and built by Astronautics) could take three astronauts 200 miles into space for almost a month of scientific studies.

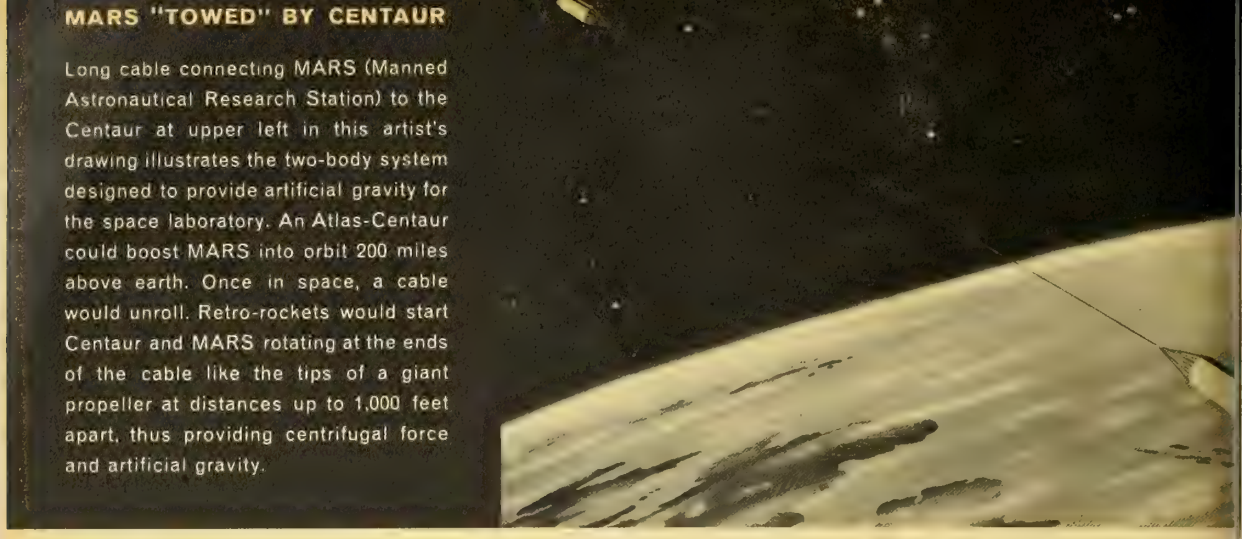
MARS typifies the advanced planning and technical resourcefulness that have made General Dynamics | Astronautics an ideal association for space-minded engineers. We're also at work on such Atlas-Centaur programs as *Mariner*—a deep space probe to the vicinity of the planet Venus—and *Surveyor,* which will soft-land an instrumented package on the moon.

Atlas-Centaur is the free world's first space vehicle to be powered by liquid hydrogen. It not only opens our entire solar system to research, but creates extraordinary opportunities for engineers who look beyond the present state-of-the-art — men who are somehow not content with the status quo.

If you're that sort of man, we urge your inquiry. It entails no obligation, of course, and may prove to be of tremendous mutual advantage. Use the attached Professional Inquiry Card, or write in confidence to Mr. R. M. Smith, Manager of Industrial Relations Administration-Engineering, Department 130-90, General Dynamics | Astronautics, 5741 Kearny Villa Road, San Diego 12, California.

GD

ENERAL DYNAMICS | ASTRONAUTICS



MARS "TOWED" BY CENTAUR

Long cable connecting MARS (Manned Astronautical Research Station) to the Centaur at upper left in this artist's drawing illustrates the two-body system designed to provide artificial gravity for the space laboratory. An Atlas-Centaur could boost MARS into orbit 200 miles above earth. Once in space, a cable would unroll. Retro-rockets would start Centaur and MARS rotating at the ends of the cable like the tips of a giant propeller at distances up to 1,000 feet apart, thus providing centrifugal force and artificial gravity.

Immediate openings exist in the following categories:

Base Activation
These positions require design or liaison engineers with experience in electrical or mechanical systems. Assignments will be for liaison work at missile launching complexes or design support work on launch control equipment, propulsion systems, automatic programming and missile checkout equipment operations at Roswell, N. M. and Plattsburgh, N. Y. BS in ME or EE required.

Field Test Engineering
Openings are for engineers with field test or design experience, who possess a BS degree in EE, AE or ME. Specific openings exist in:

Electrical and Electronic Systems
(Launch controls, logic control systems, communications systems, automatic checkout equipment, guidance and flight control, facility electrical power and electronic systems)

Mechanical Systems
(Fluid transfer, propulsion, fluid and gas dynamics, air temperature control, and missile lift)

Assignments are at Vandenberg AFB, Santa Maria, California, and Sycamore Canyon, San Diego, California.

Electrical Design
A number of assignments are available in the design of launch control systems, packaging, test equipment, missile electrical power systems, and component and systems tests. Openings also exist in vendor qualification selection, and test of ground and airborne missile electrical equipment, as well as design. A BSEE or MSEE and appropriate experience are required.

Computer Programming
For integrated data processing with both engineering and non-engineering application on 7090 and 7070. PhD, MS and BS degrees in math, physics, or business administration with 4 years of experience programming for 704, 709, or 7090 computers.

Electronic Engineering
Experienced electronic engineers required for assignments in telemetry, radiation systems, trajectory measurement, tracking, guidance, automatic controls, packaging, instrumentation, digital devices, printed circuitry, logic design, component and systems testing or measurement systems. Openings exist in design, development, reliability, vendor qualification selection, and test on ground and airborne electronic components, subsystems and systems.

Reliability Engineering
These assignments involve the establishment of electrical/electronic reliability requirements, conducting tests and test analyses, and maintenance of reliability program surveillance. A background in systems test or analysis and a BSEE are required.

Mechanical Design
Assignments involve design and development of missile air frames, ground support equipment, hydraulic or pneumatic systems. BSAE or ME required.

Technical Writing
Varied openings are immediately available to capable writers. Assignments involve technical reports and manuals, manual subcontractor control, manual change control, technical manual verification, and proposal writing. Background should include experience in technical publications and some college or formal technical training.

Openings also exist in these other specialties:
Circuit Design, Data Transmission, Design Liaison, Dynamics, Engineering Administration, Field Service, Flight Test, Guidance Systems Analysis, Human Factors, Logical Design, Metallurgy, Microwave Design, Quality Control, RF Circuitry, Structural Design, TV Engineering, Telemetry and Thin Films.

If the inquiry card has been removed, or if you wish to furnish or request more detailed information, please write to Mr. R. M. Smith, Manager of Industrial Relations Administration-Engineering, Mail Zone 130-90, General Dynamics | Astronautics, 5741 Kearny Villa Road, San Diego 12, California.

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GENERAL DYNAMICS | ASTRONAUTICS

This thin panel stopped a meteorite

(man-made, traveling at 21,000 feet per second)

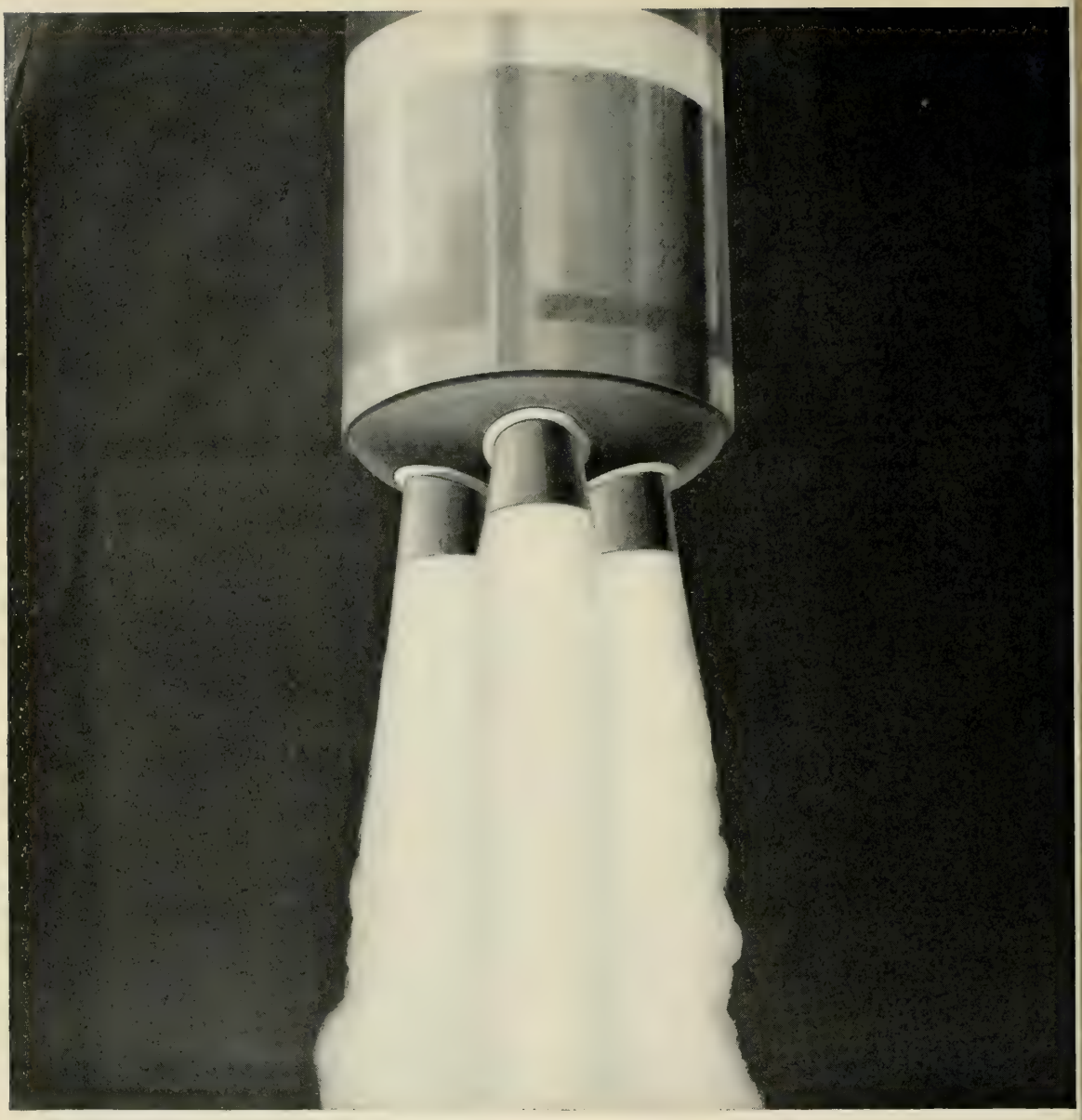


A steel pellet struck this panel at 21,000 feet per second — more than six times the speed of a high powered rifle bullet — but could not pierce it. It disintegrated after puncturing the outer metal skin, and dissipated all its energy without reaching the inner lining.

This composite honeycomb panel is one of the techniques Northrop is developing to protect spacecraft against meteorite collisions. The entire lightweight panel is less than half an inch thick, and the honeycomb is filled with sealant to prevent air from escaping in case a particle should ever penetrate.

Though most of the meteorites a spacecraft is likely to encounter will be fine as dust, some may be as large as buckshot, and dense enough to puncture an ordinary metal skin. The search for materials to meet this hazard is another example of Northrop's practical work on the problems of space.

NORTHROP



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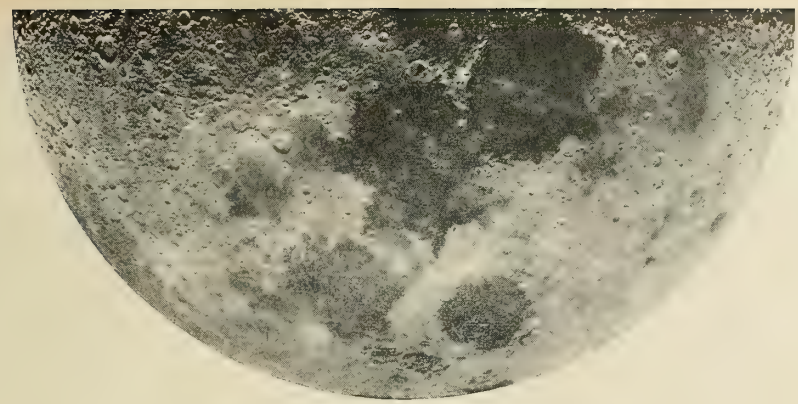
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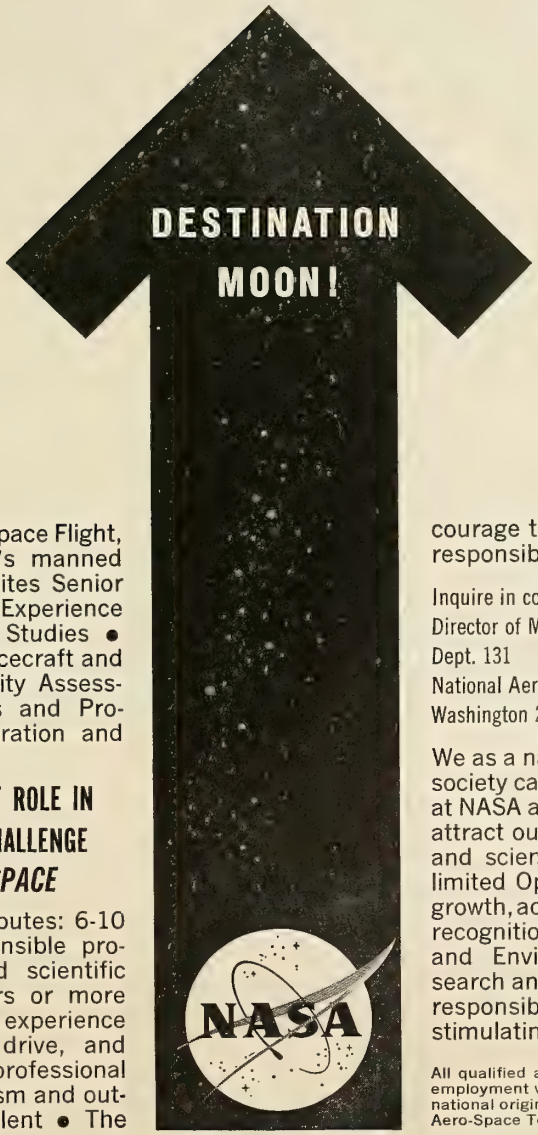
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THE LONELIEST MEN

Throughout his existence, man has always lived in an environment that nurtures life, surrounded by his fellow man.

Now he is leaving this familiar environment and entering a realm where no life as we know it exists. It is an infinite realm. And it is more lonely than any wilderness man has ever encountered before.

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Already, man has taken the first steps into space. And in the coming years he will reach farther and farther into space, traveling thousands of miles, living for days and weeks and even months in an alien environment.

The success of these journeys is one of the greatest challenges in the history of American industry. It has given the word "reliability" a depth of meaning it has never known before.

Indeed, the reliability demands for space travel are staggering. To assure a 99.9%



ance of return, a space traveler must have equipment whose mean-time-between-lures is 1000 times the expected length of the flight. This means that on an 8½-onth trip to Mars the vehicle would have to be built to last more than 700 years.

Certainly no one is more aware of these immense reliability requirements than the gineers and scientists of the aerospace industry. Time after time they are called on assure reliability in systems that have not even been designed. And time after time e desired reliability has been there when needed.

These unrelenting efforts by the aerospace industry are helping the Free World's tronauts in their conquest of outer space. They are helping the loneliest men on the neliest job in the world today.

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GUIDED MISSILES RANGE DIVISION

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Lockheed Propulsion

(Continued from page 36)

to-earth philosophy of adhering to profit and schedule goals. You can't get your sympathy quotient too high for the engineering problem or devote too much time to experiment. You've got to get the product out the back door."

A key job in the revitalized company is held by Cushman. In a reorganization last December, some functions were transferred to his operations division, including tool engineering, methods engineering and production.

"Right from the beginning the production people and the methods engineering personnel work with the development engineers as a team. Output of the production-type people is fed right into the engineering concept from the start," Cushman said.

"Some companies have a research and engineering department which comes up with an article and then turns it over to its own prototype shop. After this is completed, the whole package is turned over to the production department, which corresponds to my operations, and then they have to go through the whole production engineering phase. This takes time and costs money.

"During the development phase, our production-type people, plus the methods engineering people, work with the development-type personnel as part of a team, so specifications are developed together. We have no prototype shop. By having an integrated team, we go from development into production without a change of team members. The emphasis just changes from R & D types to manufacturing and production types.

"We do this to be competitive. I think a lot of companies are going through this transition. I don't know how the others are doing it, but I feel sure they are not as closely integrated."

LPC, which currently has a staff of 550, has its operations spread over 12,-700 acres at three locations. The main plant site is at Redlands, 65 mi. east of Los Angeles. On its 775 acres are propellant mixing, fuel and liner preparation, lining, oxidizer preparation and motor processing facilities, a large solid cost and cure station and ovens.

The Beaumont, Calif., proving grounds, 15 miles from Redlands, consists of 2831 acres devoted to advanced test facilities for medium size motors.

The 9100-acre Potrero Ranch site, in an isolated valley south of Beaumont, is the newest facility. In addition to the test stand and nondestructive test installations there, LPC has plans for a 300-gal. vertical mixer. Propellant, meanwhile, can be mixed and transported from Redlands. Cast and cure ovens are now going in at Potrero.

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Circle No. 13 on Subscriber Service Card

SCIENTISTS AND ENGINEERS:

Today the men of Motorola's aerospace team are applying creative mindpower to the analysis, design, construction and test of advanced space communications command and control systems. Vital contributions are being made to such important current NASA programs as the Goddard cis-lunar Range and Range Rate Tracking System... the JPL Mariner and Ranger unmanned planetary and lunar probes... and updating of the Deep Space Instrumentation Facilities to "S-band" for JPL. If you are interested in shaping the future with a dynamic aerospace contractor on these and other programs, we can offer immediate opportunities to both System and Equipment Design Engineers. Write us today describing in detail your experience in the following areas of aerospace technology:

System Design • communications, telemetry, command and control, radio tracking, data handling, and detection and correlation.

Equipment Design • deep space satellite and missile transmitters and receivers, high-sensitivity ground receivers, data processing equipment, data storage and display equipment, telemetry systems.

Familiarity with State-of-the-Art • multiple sensor data correlation, coding techniques, high-frequency solid state designs, integrated circuitry applications, ultra-reliability design techniques, and phase-lock and correlation techniques.

We are particularly interested in the programs on which your experience was obtained, and the extent of your technical responsibility. Address this information to our Manager of Engineering for immediate and confidential attention.

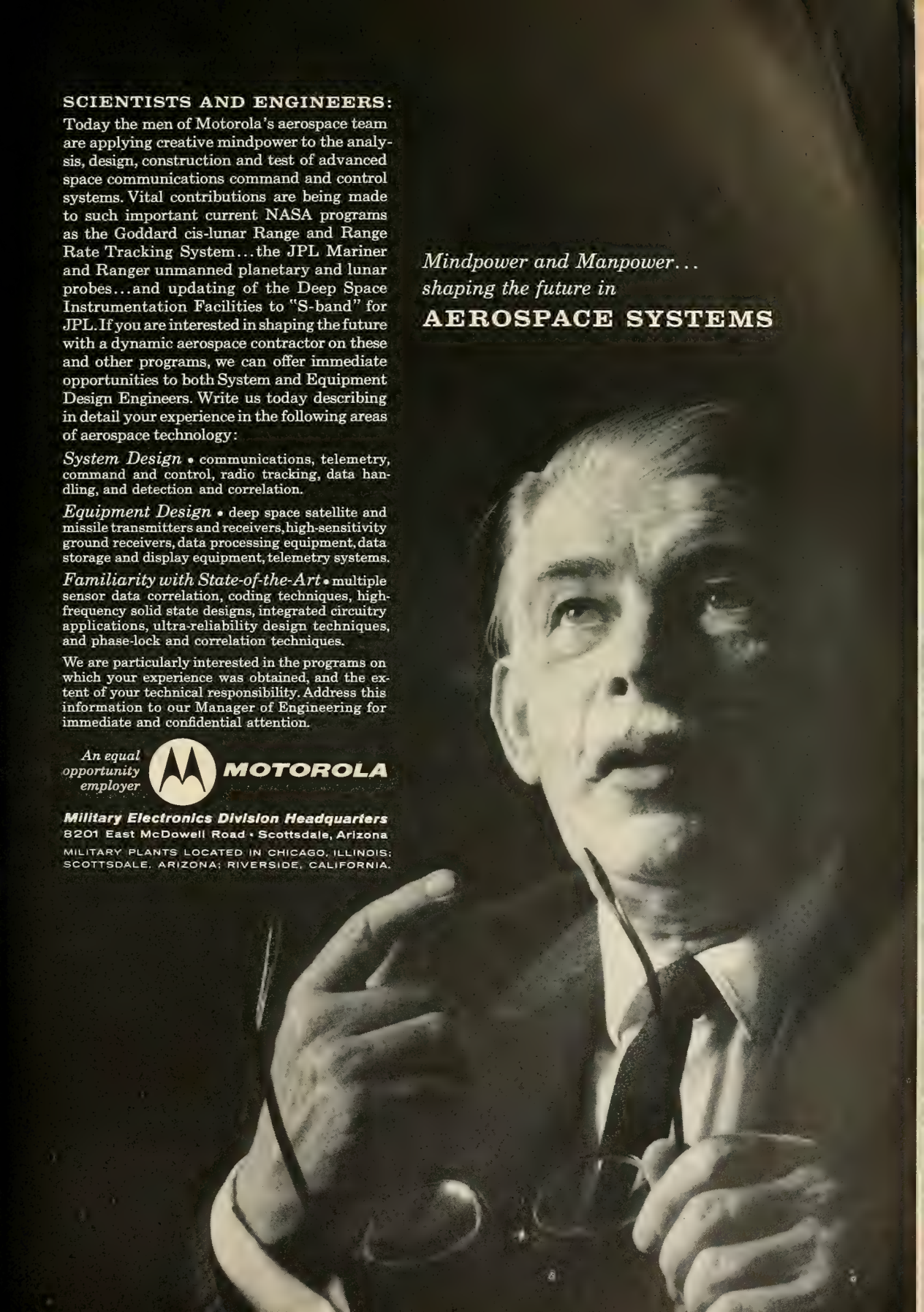
An equal opportunity employer

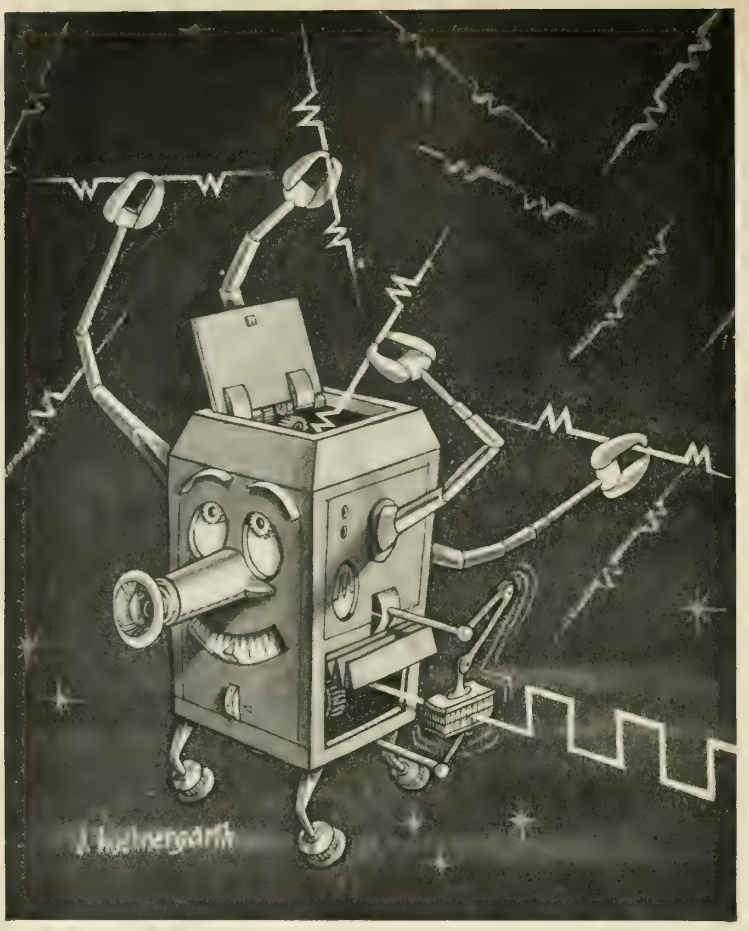
MOTOROLA

Military Electronics Division Headquarters
8201 East McDowell Road • Scottsdale, Arizona

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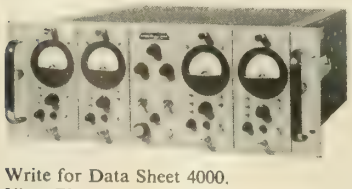
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Rejuvenate tired, dirty signals with NEMS-CLARKE® Universal Combiner!

Recent competitive tests rank this new universal signal-controlled combiner, the DCA 4000, the best of the AGC post-detection combiners. It accepts signals from up to four separate receivers and produces a single output with a signal-to-noise ratio better than the best input signal. It can be used for combining communications signals or any type of signal presently defined under IRIG standards. This equipment was designed and constructed in accordance with the requirements of MIL-E-4158 (USAF) and has a stability of continuous operation for a minimum of eight hours without readjustment.



Write for Data Sheet 4000.
Vitro Electronics, 919 Jesup-Blair Dr.
Silver Spring, Maryland
A Division of Vitro Corp. of America

SPECIFICATIONS

Type Reception
FM/FM or FM/Pulse, (PDM, PCM, PAM)
Diversity Channels . . . . . 2, 3 or 4
S/N Ratio Improvement for Equal S/N Ratio Input Signals
4 channels 5 to 6 db
3 channels 4 db to 4 7 db
2 channels 2 0 db to 3 0 db
Output Impedance . . . . . 75 ohms
Stability . . . Eight hours continuous without readjustment

Vitro ELECTRONICS

'Secret' Satellites

(Continued from page 14)

date of the *MIDAS* early warning satellite. Haunted by memories of the U-2 incident, the Administration seems to be hedging against the day when an operational "spy-in-the-sky" system will be operational—estimated to be late this year or early 1963.

That the Administration expects it will soon have an operational satellite early warning system was intimated by President Kennedy in his May 17 press conference.

In answer to a question as to why we have no ICBM warning system to the south of us, in view of Soviet claims that they might be able to attack from that direction, the President said that "as time goes on, such a system will be developed." Since Defense officials admit the unlikelihood of a south-facing BMEWS system, the President is assumed to have been talking about a satellite warning system, such as *MIDAS*.

Anticipating Russian protests that the space over their country is being invaded for espionage purposes, the Administration is classifying satellite launchings so that *MIDAS* and *SAMOS* flights will not be readily identifiable.

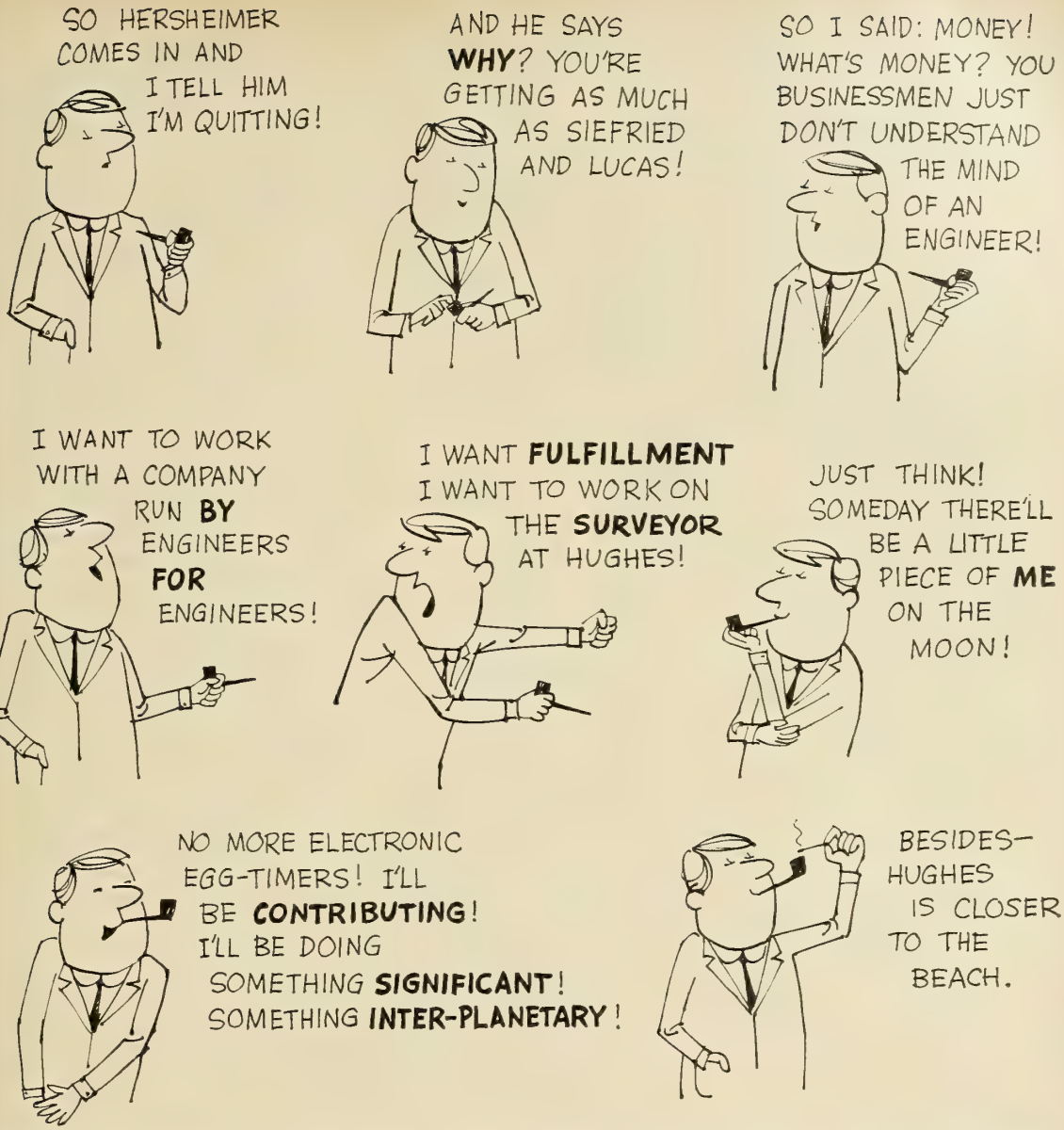
The apparent plan, when these systems become operational, is to deny that satellites passing over Russia are anything other than peaceful, scientific space vehicles.

• **Congress disturbed**—Added to the grumblings of newsmen and AF officials is the divided attitude of Congress toward the new policy.

On the one hand, members of the House Science and Astronautics Committee have expressed concern over the policy and appear to oppose it. On the other hand, Rep. Olin Teague (D-Tex.) has introduced a resolution in the House to curtail all space information given to the Russians until they show a more "cooperative" attitude.

The Defense Appropriations Subcommittee of the House Appropriations Committee, has voiced some worry that we are giving out too much information. After recent testimony by Dr. Harold Brown, Director of Defense Research & Engineering, they questioned the classification of his statement, and said they were especially concerned over the amount of information gained by the Soviets from our space program.

Conversely, the Freedom of Information Subcommittee of the House Government Operations Committee headed by Rep. John Moss (D-Calif.) is reportedly looking into the directive for signs of excessive classification.



Hughes is hiring! Numerous opportunities now exist in a variety of advanced projects and studies. Examples include: The SURVEYOR—which will soft land an instrumented payload on the moon. ARPAT—terminal anti-missile defense system. VATE—automatic test equipment for ballistic missiles. SYNCOM—synchronous-orbit communications satellite. BAMBI—ballistic anti-missile booster intercept. Positions are open at all levels for specialists with degrees from accredited universities.

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Mr. Robert A. Martin
Head of Employment
Hughes Aerospace Divisions
11940 W. Jefferson Blvd.
Culver City 44, California

CONTROLS ENGINEERS. Concerns airborne computers and other controls related areas for: missiles and space vehicles, satellites, radar tracking, control circuitry, control systems, control techniques, transistorized equalization networks and control servomechanisms.

CIRCUIT DESIGNERS. Involves analysis and synthesis of systems for: telemetering and command circuits for space vehicles, high efficiency power supplies for airborne and space electronic systems, space command, space television, guidance and control systems, and many others.

INFRARED SPECIALISTS. To perform systems analysis and preliminary design in infrared activities for satellite detection and identification, air-to-air missiles AICBM, infrared range measurement, air-to-air detection search sets, optical systems, detection cryogenics and others.

SYSTEMS ANALYSTS. To consider such basic problems as: requirements of manned space flight; automatic target recognition requirements for unmanned satellites or high speed strike reconnaissance systems; IR systems requirements for ballistic missile defense.

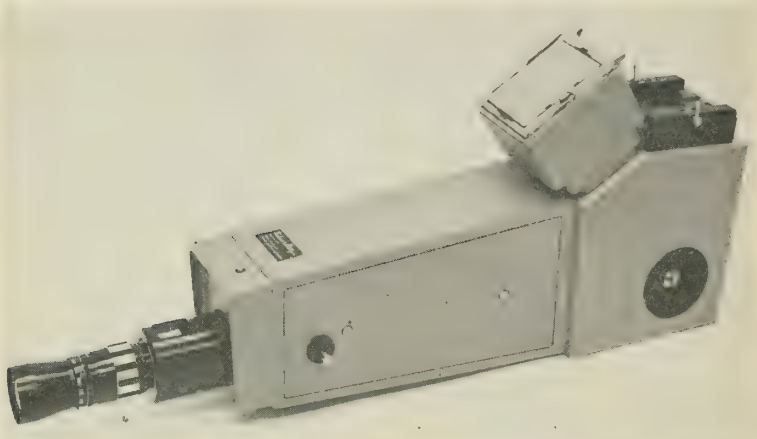


Creating a new world with Electronics

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HUGHES AIRCRAFT COMPANY
AEROSPACE DIVISIONS

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New Product of the Week: Streak and Framing Camera

THE MODEL 200-Simultaneous Streak & Framing Camera, introduced by Beckman & Whitley, Inc., is the only high-speed photoinstrument that will simultaneously record streak and framing records of the same event. Both records are taken from the same point-of-view, through the same objective lens, on the same time base. This camera makes possible positive identification and interpretation of phenomena difficult to analyze from either streak or framing records alone.

Model 200 provides the analyst with a streak record written at speeds up to 6.9 mm per microsecond, time resolved to 3.6×10^{-8} seconds and a sequence of qualitative, two dimensional pictures of the same event recorded at rates up to 550,000 frames per second. Activity between the two records can be identified with close correlation of time/space positions so that sources of minute variations in film density can be precisely determined.

Circle No. 225 on Subscriber Service Card

Compact Signal Source

A low-cost, compact signal source offering greater frequency coverage and power than heretofore available, is being marketed by the Narda Microwave Corp.

The unit, designated Model 451, covers the frequency range of 750 to 2750 Mc, and provides power output from 100 to 300 milliwatts over most of the band, with at least 10 milliwatts output even at band edges. Complete modulation is built into the single instrument, providing for internal CW, square wave or pulse modulation at a rate of 400 to 2000 cps and a variable pulse width of 0.5 to 20 microseconds. Provision is also made for external AM or FM modulation.



Circle No. 226 on Subscriber Service Card

Subminiature Rectifiers

A line of diffused-junction, silicon subminiature rectifiers with an operating capability of 50 milliamperes dc rating at 200°C ambient temperature has been announced by the General Electric Co., Rectifier Components Department. They are designed as general purpose industrial devices to be used where space is at a premium. The very low reverse current of the rectifiers make them particularly suited for magnetic amplifier applications.

Circle No. 227 on Subscriber Service Card

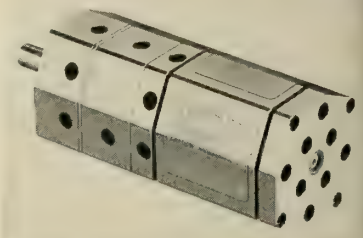
Low-Frequency Crystals

A complete line of low-frequency quartz crystals characterized by improved aging characteristics, very close tolerance over a wide temperature range and a very high Q factor has been announced by Reeves-Hoffman Div., Dynamics Corp. of America. Frequency range is from 850 cps to 50 kc with tolerance of ±0.15% maintained at temperatures from —40C to +70C.

Circle No. 228 on Subscriber Service Card

Underwater AC Motors

A line of compact, underwater AC motors, available from 1/100th to 100 HP, is announced by Electro-Kinetics Corp. Units operate solely by electromagnetic induction—hence no brushes, slip-rings, or centrifugal switches are required.



Designated "UW" series, these motors feature open-frame construction which eliminates pressure-sealed housings, and allows circulating water to cool and lubricate units. All electrical components are encapsulated to protect them from the effects of liquids.

Circle No. 229 on Subscriber Service Card

Casting Compound

A one-component casting compound which will withstand thermal shock specified under MIL-T-27A, designed specifically for transformer applications has been announced by The Acme Wire-Co.

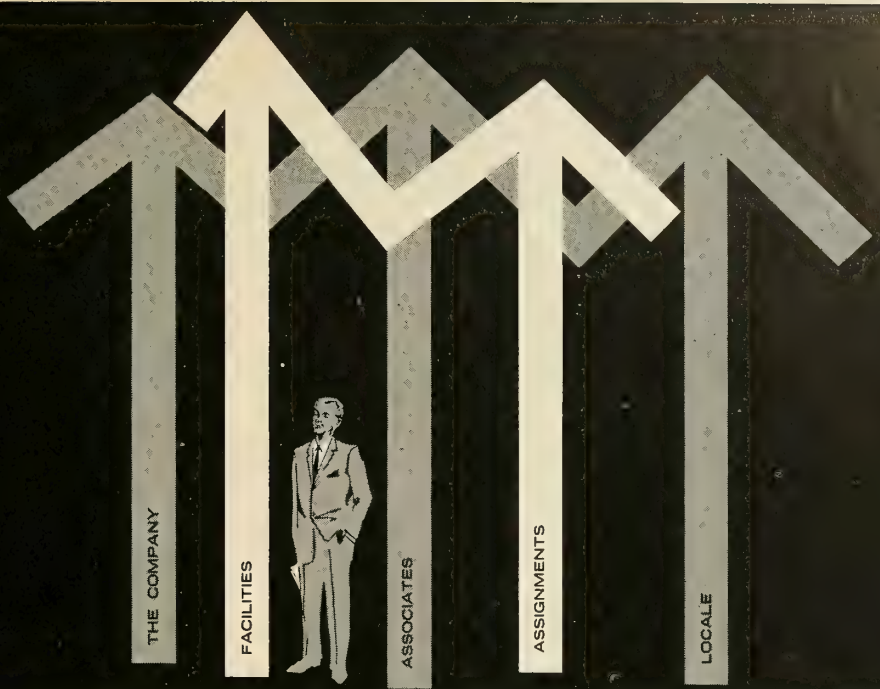
The mixture, #1400, was developed for transformers which are exposed to severe thermal shock and vibration, and has excellent handling properties at recommended pouring temperatures.

Circle No. 230 on Subscriber Service Card

Plastic Spacers/Washers

Standard and custom plastic spacers and washers for a wide variety of industrial uses are available from Plastiglide Mfg. Corp.

Injection-molded in Nylonk Tenite-



5 ELEMENTS NECESSARY FOR SUCCESSFUL PROFESSIONAL GROWTH AND YOU'LL FIND THEM ALL AT BOEING'S MILITARY AIRCRAFT SYSTEMS DIVISION

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2. FACILITIES Boeing assures the engineer he will have the "tools" available to successfully carry out assigned projects. Lab and test facilities include: IBM 7090 digital computer lab; materials and dynamic testing; facilities to conduct and evaluate flight test data; model development and wind tunnel testing; and complete electrical-electronic labs and testing facilities.

3. ASSOCIATES Engineers will find they will work with men recognized for their abilities and knowledge in various specialized fields. Proof of this is Boeing's position as a leader in the industry today.

4. ASSIGNMENTS Current assignments at the Wichita and Seattle Branches are in projects that will test the skill and imagination of the most creative engineer. Projects include: Advancing the state of the art in Variable Sweep Wing technology, conducting studies and tests in the operation of high-performance aircraft at low level, design of land-and-carrier-based V/STOL vehicles, and studies in all areas pertaining to design, development, and testing of military aircraft systems.

5. LOCALE Two outstanding geographic locations: Wichita and Seattle. Wichita, a city noted for its year 'round sunshine and fresh, clean air, and recently named an "All America City" by LOOK Magazine. Seattle, most beautiful city in the Pacific Northwest, offers unmatched scenery and recreational facilities.

To qualify you should have an engineering degree with interest and experience in any of the above areas. To save time send us a complete resume, and we'll reply immediately. Or fill in the coupon below and we'll send you an application. Send your resume or coupon to Mr. Melvin Vobach, The Boeing Company, Military Aircraft Systems Division, Wichita 1, Kansas.

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Other Divisions: Aero-Space, Transport, Vertol, Industrial Products, and Boeing Scientific Research Laboratories



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Systems, Design,
Development
PHYSICISTS

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Vitro Laboratories is expanding on all fronts . . . missile systems engineering . . . design and development . . . analysis . . . research and study. We invite you to enter the "go" climate of Vitro.

MISSILE SYSTEMS ENGINEER

System engineering in Polaris Weapons System, including analysis of various complex electro-mechanical sub-systems. Will make comparisons of sub-subsystems operations, conduct necessary studies to confirm conformance of sub-system components with operational requirements, and engage in liaison with sub-contractors to support above activities. BSEE or equivalent. Experience in design of digital circuitry and related test equipment desirable.

SR. MATHEMATICIAN

Review and analysis of Polaris system functional design to determine a proper error assignment on a computational criteria basis. BS or MS in mathematics. Four to ten years' missile systems reliability experience desirable.

ELECTRICAL ENGINEER

Will analyze missile systems for good engineering practices to reduce radio frequency interference; conduct RFI measurements in lab and aboard ship to reduce specific RFI effects. Position requires experience in these areas or antenna studies, RF propagation theory, electromagnetic radiation hazard studies or associated design or evaluation. BSEE.

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Circle No. 231 on Subscriber Service Card

Electroless Copper Plating

Enplate CU-400, an electroless copper plating bath, has been developed by Enthone, Inc., a subsidiary of American Smelting and Refining Co. It produces dense, fine-grained, adherent copper deposits of uniform thickness without the use of electric current.

Enplate CU-400 chemical plating solution deposits a conductive copper film on printed circuit boards, plastics, rubber, ceramics, ferrites, glass, and other non-conductive and semi-conductive surfaces. Once rendered conductive with Enplate CU-400, the surface may be electroplated for greater buildup.

Circle No. 232 on Subscriber Service Card

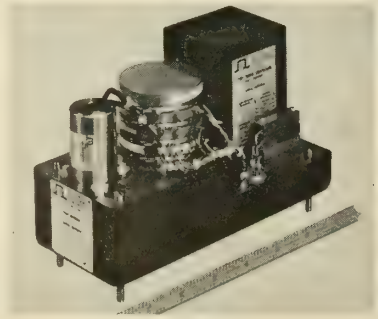
Step Servo-Module

A precision step-servo module is available from Automation Development Corp.

The unit, Model 821A, combines Step-Servo components in an integrated plug-in digital servo module used for automatic missile system testing.

The 821A includes four rotary switches and two 350° potentiometers driven by a step-servo through precision (P2) anti-backlash gearing. Bidirectional stepping rates to 165 pps are achieved with a system accuracy of one part in 500.

Circle No. 233 on Subscriber Service Card



Questions and Answers about the GLOBAL COMMUNICATIONS CAPABILITIES of RCA

What capabilities? From which subsidiary of RCA?

From RCA Communications, Inc.

Uncommon capabilities for designing and operating **ground communications networks of world-wide scope** needed by contractors, sub-contractors, and government agencies engaged in **space or missile projects.**

RCA Communications also provides facilities for private communications . . . data communications . . . and commercial communications of all kinds — telegraph, telex, radiophoto, and radiotelephone by means of radio and coaxial cable channels. It designs not only completely new systems but also systems incorporating the most efficient and economical arrangement of established facilities.

How were these capabilities acquired?

Through 41 years experience in building and operating a world-wide communications system. Today, RCA's integrated telegraph, telex, and radiophoto networks reach more than 100 countries and ships at sea.

In what ways does RCA make its capabilities available?

As contractor or consultant. For more information, write RCA Communications, Inc., Advanced Projects Section, 66 Broad St., New York 4. Tel. Hanover 2-1811, Area Code 212.

RCA® **The Most Trusted Name in Communications**

new literature

SPHERICAL BEARINGS—Spherical bearings and rod ends, their capacities and their applications are described in a new brochure available from Stephens-Adamson Mfg. Co. The 16-page brochure illustrates with charts and diagrams the wide range of designs, bore diameters, thread sizes and materials in "Spherco" bearings.

Circle No. 200 on Subscriber Service Card

DIRECT-READING MICROMETERS—A handy, pocket-size folder describing in detail a line of direct-reading micrometers is available from the J. T. Slocombe Co. The eight-page booklet is illustrated with examples of Slocomb's Speedmike line and includes cut-away artwork which clearly shows how the direct-reading mechanism works.

Circle No. 201 on Subscriber Service Card

DIGITAL SHORT-FORM CATALOG—A listing of 86 fully coordinated solid-state computer circuit modules is included in a new short-form catalog released by Digital Equipment Corp. Featuring a quick-reference table showing Digital modules arranged according to type, the catalog also provides a brief description and a price listing of 40 pieces of accessory and high-current pulse equipment. Digital manufactures four basic lines of circuit modules: Laboratory Module line; System Module line; Digital Training Modules; Digital Classroom Modules.

Circle No. 202 on Subscriber Service Card

RECORDER/REPRODUCER — A four-page bulletin describing the outstanding characteristics of the GR-2800 Magnetic Tape Recorder/Reproducer is now available from the Data Recorders Div. of Consolidated Electrodynamics Corp. It is a fully integrated recorder-reproducer system designed for industrial and military data storage applications requiring the highest accuracy and maximum reliability. All electronics are solid-state. Record and reproduce amplifiers are the plug-in type, employing printed-wiring circuits.

Circle No. 203 on Subscriber Service Card

BOWMAR'S NEW "LC" COUNTERS BROCHURE—A four-page combination technical bulletin and descriptive brochure on "Series LC" modular type decimal counters has been published by Bowmar Instrument Corp. It contains general information as well as detailed schematics on 3-, 4-, and 5-drum counters which conform to military, industrial and commercial standards.

Circle No. 204 on Subscriber Service Card

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Markets Labor Transportation

Pennsylvania is strategically situated to serve the major East-Central market and population centers. The ample work force available ranks high in educational levels, productivity and adaptability. An excellent transportation network moves goods and materials quickly and economically.

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There is no Property Tax on manufacturer's machinery, equipment or inventory . . . no tax on real property. Manufacturing capital and equipment are exempt from both Capital Stock and Franchise Tax, and from the Sales and Use Tax. There's no Stock Transfer Tax, nor Personal Income Tax.

100% Financing

The "Pennsylvania Plan" offers 100% Financing on lease or lease purchase of plant facilities. At latest count, the Pennsylvania Industrial Development Authority has made 211 project loans, totaling $26,024,602—to build or expand plants representing an investment of $77,622,583.

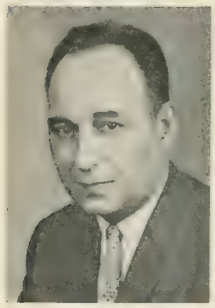
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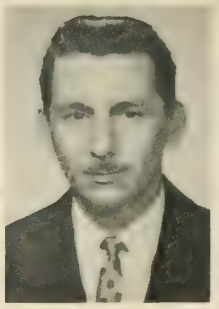
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DIRECTOR OF INDUSTRIAL DEVELOPMENT
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Phone: CEdar 4-2912

names in the news


GEPHART


ZILM


MATHESON


HORSMAN


RYAN

George J. Jelniker: Appointed manager of Hughes Aircraft Co.'s new field office in Houston.

Leonard A. Freeman: Named president and chief executive officer of Micom Inc., Dallas.

M. H. Meyerson: Joined Mid-Eastern Electronics, Springfield, N. J., as chief power systems engineer.

Arthur L. Malcarney: Promoted to group executive vice president of Radio Corp. of America, New York. **Theodore A. Smith** named executive vice president for corporate planning and **Walter G. Bain** named vice president, defense electronic products.

Dr. Landis S. Gephart: Former top official of NASA, now director of products assurance for space systems, Lockheed Missiles & Space Co., Sunnyvale, Calif.

Dr. Robert Spencer Bradford: Appointed research manager of Mincom div., Minnesota Mining and Manufacturing Co., Los Angeles.

George T. Bell, Jr.: Elected president of Geonautics, Inc., Washington, D. C. **Carl I. Aslakson** elected chairman of the board.

Charles F. Zilm: Appointed marketing manager and engineering liaison of proprietary items by Resdel Engineering Corp., Pasadena, Calif.

Charles W. Newhall, Jr.: Former president of Flight Refueling, Inc., of Baltimore, appointed assistant to the president of Marquardt Corp., Van Nuys, Calif.

Raymond E. Zelenka: Appointed chief engineer of Allied Research Associates, Inc., Boston.

George Molchan: Named chief of procurement for Connecticut Advanced Nuclear Engineering Laboratory (CANEL) at Middletown.

Dr. Willard Matheson: Elected vice president of Acoustica Associates, Inc., Los Angeles.

William W. Horsman: Appointed contract administrator at Beta Instruments Corp. of Dallas.

George M. Ryan: Elected president of Benson-Lehner Corp., Santa Monica, Calif.

E. R. Wagner: Appointed vice president and assistant to the president of Emertron, Inc., Washington, D. C.

Dr. Ernest E. Pittelli: Appointed physics specialist at Applied Research Laboratory of Sylvania Electric Products, Inc., Waltham, Mass.

Arthur A. Turner: Promoted to general manager of The Carborundum Co.'s refractories and electronics division in Perth Amboy, N. J.

Maj. Gen. Earle E. Cook: Deputy Signal Officer, Washington, D. C., appointed Chief Signal Officer, U. S. Army, following the retirement of **Maj. Gen. Ralph T. Nelson.**

Dr. Charles Stark Draper: Founder and director of the MIT Instrumentation Laboratory and head of the Dept. of Aeronautics and Astronautics at MIT, will receive the 1962 National Society of Professional Engineers Award for outstanding service to the engineering profession.

Dr. Herbert Sukenik: Joined Martin Company's space systems division, Baltimore, as chief of space medicine in the life sciences department.

Dr. William P. Senett: Former principal scientist with the electronics division of General Dynamics, named director of advanced technology of Leesona Moos Laboratories, Jamaica, N. Y.

Norman H. Ressler: Appointed applications engineer for the space environmental test division of Astrosystems International, Livingston, N. J.

Dr. Milton A. Grodsky: Martin Company scientist, will receive the 1962 achievement award of the American Rocket Society's Maryland section.

Charles W. Hutton: Appointed assistant to Charles R. Able, vice president-general manager of the missile and space systems division of the Douglas Aircraft Co., Santa Monica, Calif.

Dr. David A. Kahn: Formerly systems research department manager of the Cornell Aeronautical Laboratory, named to the newly created position of systems associate, Melpar, Inc., Falls Church, Va.

D. J. Cockeram: Appointed director of reactor development of Atomics International, Canoga Park, Calif. **R. O. Williams, Jr.,** named director of nuclear operations.

Sherman R. Rodgers: Named manager of quality control for the Studebaker-Packard Corp., CTL division, western operations, Santa Ana, Calif. **Richard C. Kostner** named plant manager and **Joseph W. Wiechowski,** western operations manager.

George Rappaport: Former vice president of Emerson Radio & Phonograph Corp., Chicago, elected president and chief executive officer of Warnecke Electron Tubes, Inc.

Lawrence J. Straw: Elected corporate vice president-marketing by the board of directors of American Electronics, Inc., Fullerton, Calif.

Robert C. Brown: Appointed director of engineering of Wellington Electronics, Inc.

James R. Nall: Named president of the recently formed Molecular Science Corp., Menlo Park, Calif.

James F. Thornbury: Elected president of Casa Electronics Corp., Los Angeles. **Winston Key** elected vice president.

Richard H. Curtis: Appointed director of the Missile and Space Council of the Aerospace Industries Association, Washington, D. C.

Reginald L. McKenzie: Named vice president and treasurer of Aerojet-General Corp., Azusa, Calif.

contracts

AIR FORCE

$5,826,547—**General Dynamics Corp.**, San Diego, for work on the global tracking network ground system (supplemental contract).

$5,140,000—**North American Aviation, Inc.**, Downey, Calif., for guidance and control equipment for *Minuteman* missiles.

$4,924,999—**Massachusetts Institute of Technology**, Cambridge, for research on re-entry physics, acquisition of specialized equipment and research on range measurements (supplemental contract).

$4,432,000—**Bendix Systems Div.**, Ann Arbor, Mich., for work on a classified project (supplemental contract).

$4,125,000—**Philco Corp.**, for satellite control equipment. Work to be done at Palo Alto, Calif. (supplemental contract).

$3,819,538—**Lockheed Missiles & Space Co.**, Sunnyvale, Calif., for component improvement of *Agena* space vehicles (supplemental contract).

$3,454,000—**Sperry Gyroscope Co.**, Great Neck, N.Y., for instrumentation for missile tracking ships (supplemental contract).

$3,349,000—**Douglas Aircraft Co.**, Santa Monica, Calif., for work on *Skybolt* missiles.

$3,300,000—**Aerospace Corp.**, El Segundo, Calif., for provision of system engineering, technical direction, management services and administrative support for ballistic missile and space programs.

$3,150,000—**Hercules Powder Co.**, Wilmington, Del., for research and development for Stage III *Minuteman* motors (supplemental contract).

$2,859,000—**International Business Machines**, Rockville, Md., for development and implementation of intelligence data-handling subsystems.

$2,800,000—**Lockheed Missiles & Space Co.**, Sunnyvale, Calif., for research and development on space satellite systems (supplemental contract).

$2,100,000—**American Air Filter Co.**, Rock Island, Ill., for *Minuteman* environmental control systems.

$2,000,000—**Marquardt Corp.**, Van Nuys, Calif., for Project *Apollo* reaction control rocket engines.

$1,915,057—**Martin Marietta Corp.**, Denver, for follow-on *Titan I* missiles and related equipment.

$1,493,953—**Hughes Aircraft Co.**, Culver City, Calif., for work on the *Falcon* missile weapon systems (supplemental contract).

$1,155,596—**Lockheed Missiles & Space Co.**, Sunnyvale, Calif., for long-lead time items for *Agena* space vehicles.

$1,310,000—**Aerojet-General Corp.**, Sacramento, for motors and related equipment for *Minuteman* intercontinental ballistic missiles.

$1,000,000—**Ralph M. Parsons Co.**, Pasadena, Calif., for a study program relating to *Minuteman*.

$1,000,000—**North American Aviation, Inc.**, Downey, Calif., for *Minuteman* guidance and control systems (supplemental contract).

$1,000,000—**General Dynamics Corp.**, San Diego, for work on *Atlas* missile sites.

NAVY

$3,282,904—**General Electric Co.**, Pittsfield, Mass., for guidance units for *Polaris* missiles.

$2,902,847—**Raytheon Co.**, Lexington, Mass., for missile flight tests and missile repairs for the *Sparrow III* missile.

$2,863,000—**Sperry Gyroscope Co.**, Syosset, N.Y., for implementing a program to alter equipment, parts and components for the *Polaris* submarine navigation system.

$2,598,503—**Goodyear Aircraft Corp.**, Akron, Ohio, for continued research and development work on the *Subroc* underwater missile.

$2,116,408—**Hercules Powder Co.**, for continued research on missile propellants. Work to be done at Pinto, West Va.

$1,572,000—**General Dynamics Corp.**, Daingerfield, Tex., for continued research and development on the *Bumblebee* missile program.

$1,108,925—**Philco Corp.**, Philadelphia, for guidance and control sections for *Sidewinder* missiles.

ARMY

$19,874,524—**Raytheon Co.**, for production of the guidance and control section of the *Hawk* air defense guided missile. Work to be done at Andover and Lowell, Mass., and Bristol, Tenn.

NASA

$1,000,000—**International Business Machines**, Rockville, Md., for five *Saturn* guidance computer units.

$187,000—**Perkin-Elmer Corp.**, Norwalk, Conn., for a series of long-range theodolite instruments to be used to align the inertial guidance systems of *Saturn* space rockets prior to launch.

General Dynamics Corp., San Diego, for design and manufacture of a launch vehicle (*Little Joe II*) to be used to boost the *Apollo* spacecraft on unmanned suborbital test flights (undisclosed amount).

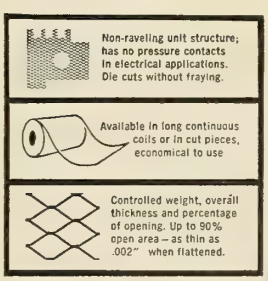
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$35,500,000—**Radio Corp. of America**, from **The Boeing Co.**, for manufacture of the electronic command network equipment for the first wing of the *Minuteman* ICBM.

$3,000,000—**Telex, Inc.**, Minneapolis, from **Lockheed Aircraft Corp.**, for electronic components.

$900,000—**Sperry Gyroscope Co.**, Great Neck, N.Y., from **Autonetics Div. of North American Aviation**, for *Minuteman's* missile airborne guidance system.

$900,000—**Twin Industries Corp.**, Buffalo, N.Y., from **Laboratory for Electronics, Aerojet-General, RCA, Electro-Mechanical Corp. and Motorola**, for aircraft and missile components.



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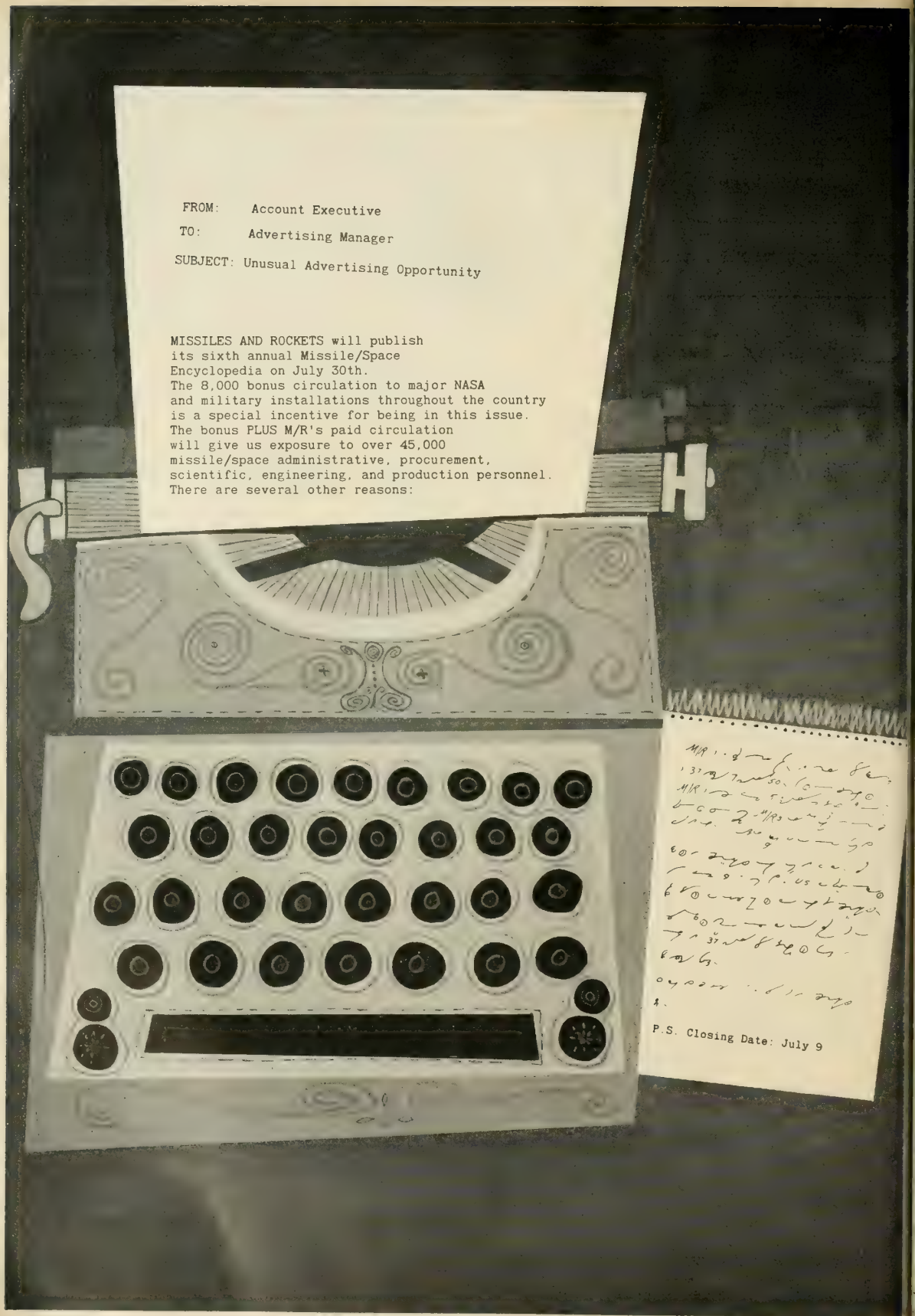
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The First Annual Convention of the American Association for Contamination Control, Jack Tar Hotel, San Francisco, May 28-30.

JUNE

Edison Electric Institute, Annual Convention, Atlantic City, N.J., June 4-6.

Engineers Joint Council, Nuclear Congress and Exhibit, The Coliseum, New York City, June 4-7.

Society of Technical Writers and Publishers, Annual Meeting, Sheraton Hotel, Philadelphia, June 6-8.

Society of Automotive Engineers, Inc., Summer Meeting, Chalfonte-Haddon Hall, Atlantic City, N.J., June 11-15.

Molecular Beams Conference, Brookhaven National Laboratory, Upton, N.Y., June 11-13.

Cornell University Seminars in Industrial Engineering Operations Research and Statistics, Ithaca, N.Y., June 12-15.

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Big Boosts for Propulsion

TWO SIGNIFICANT contract decisions in the propulsion field recently have moved this portion of the industry ahead in giant steps.

The importance of the awards lies not so much in the companies to which they went as in the advances in technology which are promised by the new concepts involved.

By coincidence, the two firms receiving the contracts are only a few miles apart in the town of Sunnyvale, Calif. The first of these awards is the decision on the part of the Air Force to negotiate with United Technology Corp. the contract for the 120-inch boosters for *Titan III*.

This is the first major step forward in recognition of solid propulsion, which for too long has been the stepchild of booster funding. It is recognition of recent developments in segmented solids which promise to speed advancements in this area at an even faster rate.

It is an indication that several considerable problems have been overcome in the development of large solids:

- Uncertainty as to behavior of very thick propellant webs necessary to accomplish booster performance.
- Limitations on materials and fabrication technology associated with large, long-duration nozzles.
- Definition of the most reliable and least expensive thrust vector control technique.
- Questions about the feasibility of full-diameter mechanical joints on segmented rockets.

But there are other important nontechnical considerations in the selection of United Technology which generally have been overlooked in the heat of the technical competition.

One of these is the fact that the decision introduces into the propulsion industry as a major competition a new and still relatively untried company. UTC has assembled a team of exceedingly competent rocket engineers since it was first formed in the fall of 1958 as a wholly owned subsidiary of United Aircraft Corp. This industry still is young enough that the introduction of a new and vigorous competitor in the field is an excellent thing. A number of competent firms are available to compete for contracts in the propulsion field, but the existence of one more at this stage of the game will spark an increased competence and competitive striving which cannot help but benefit the industry. If young UTC can twist Aerojet's tail on this one, so can many an aspiring team in the future.

We have cheered for Aerojet-General since its JATO days. We cheer the significant success of a competitor in the same field.

There is one more thing which should be said of the 120-inch award to UTC. United Aircraft Corp. took a considerable gamble with its investment in the Sunnyvale subsidiary. Publicly, UTC has said the amount put into its California facilities is near $15 million. In fact, this total investment probably is closer to $30 million.

Until now, there has been very little Government support of this investment in the form of contracts. Large test stands, mixers, computers, land, research and development—all have been privately funded.

UTC management was in a position to go to the Government and say, "You have told us that you want industry firms to show their good faith by investing their own money in facilities. You have told us that firms that demonstrate such confidence together with competence will receive favorable contract consideration. We now have done this."

That the Air Force in part recognized the logic of this argument in its 120-inch decision is a heartening sign for the industry. We look forward to a lively future for UTC.

THE OTHER recent contract that we regard as a significant milestone for the industry was awarded to Lockheed Missiles and Space Company for the *RIFT* nuclear stage.

For the first time in this field, a nuclear propulsion system is to be checked out by flight testing. For the first time, the potentialities of a *Nova* vehicle designed with *RIFT* as a possible upper stage come into realistic view. Use of nuclear stages to place large payloads in high Earth orbits and to carry worthwhile payloads to Venus, Mars and the Moon is envisioned.

Funding of this program by the National Aeronautics and Space Administration at an initial level of $180 million gives it a promising start. Already Lockheed has announced formation of a new program division to carry out provisions of the contract. NASA officials say the contract eventually will run into several hundreds of millions of dollars.

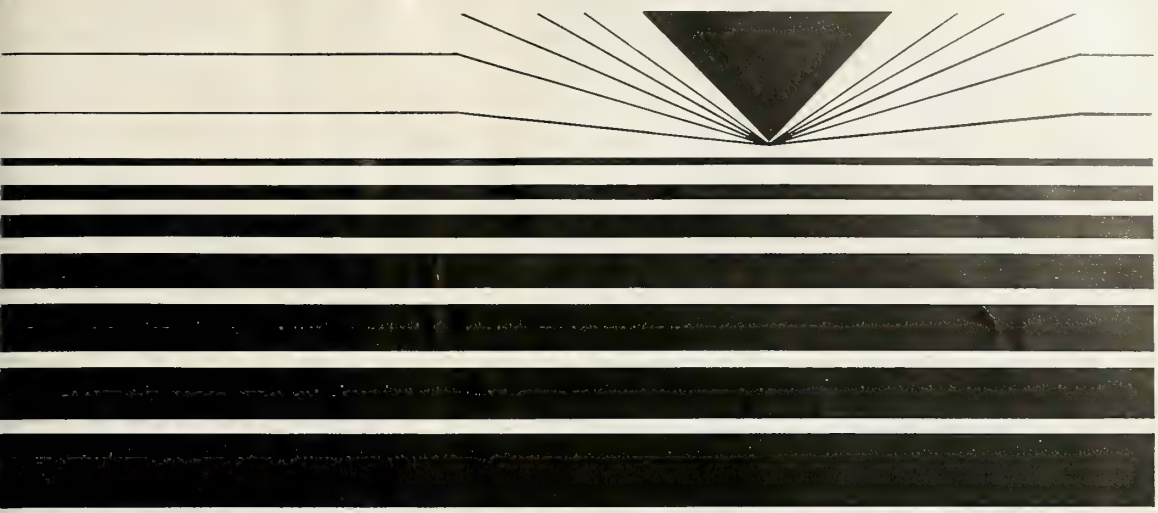
This is the type of support which will get this promising effort off the ground in a hurry. A study by two Lockheed scientists indicates that the nuclear rocket will place a given payload in a 300-mile orbit at a lower operating cost than all-chemical systems—certainly a worthwhile reason for pushing its development. But it also is expected to be much superior for Mars and Venus flights.

The decision to push development of *RIFT* and its *NERVA* nuclear engine now and the decision to take the first step into big solids with development of the 120-inch booster are important ones.

Together, they indicate that major milestones are being passed at a comfortable pace in the propulsion field.

William J. Coughlin

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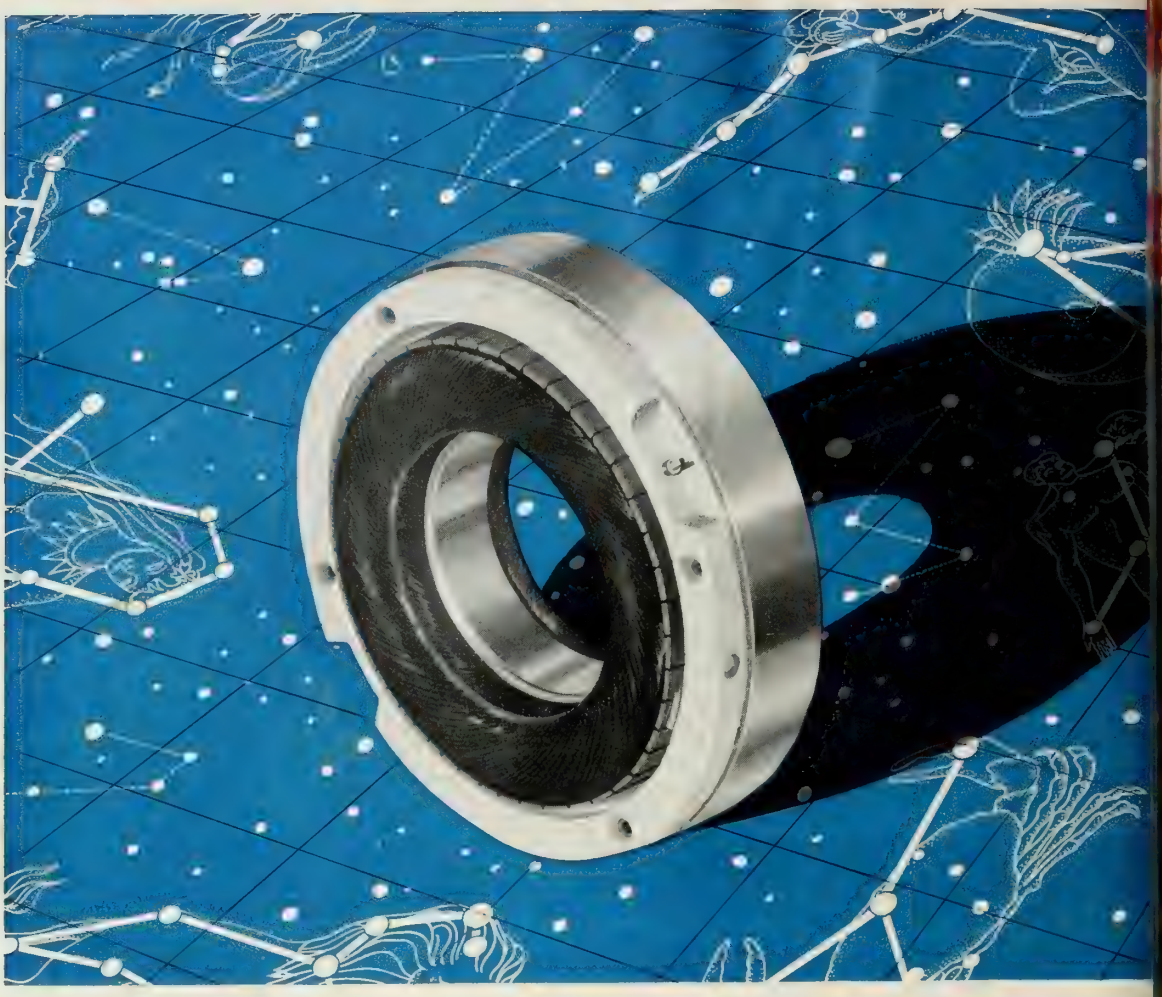
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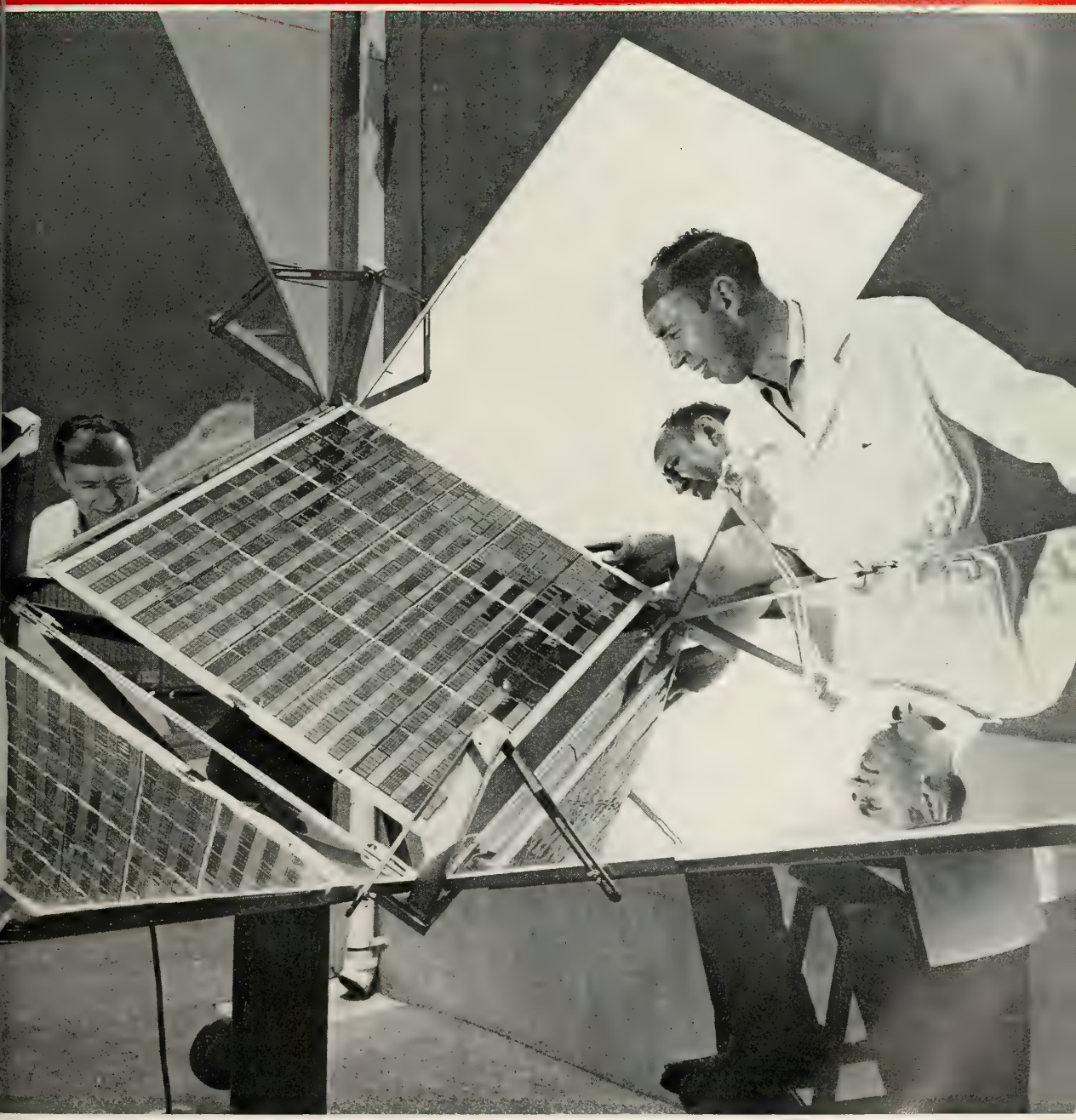
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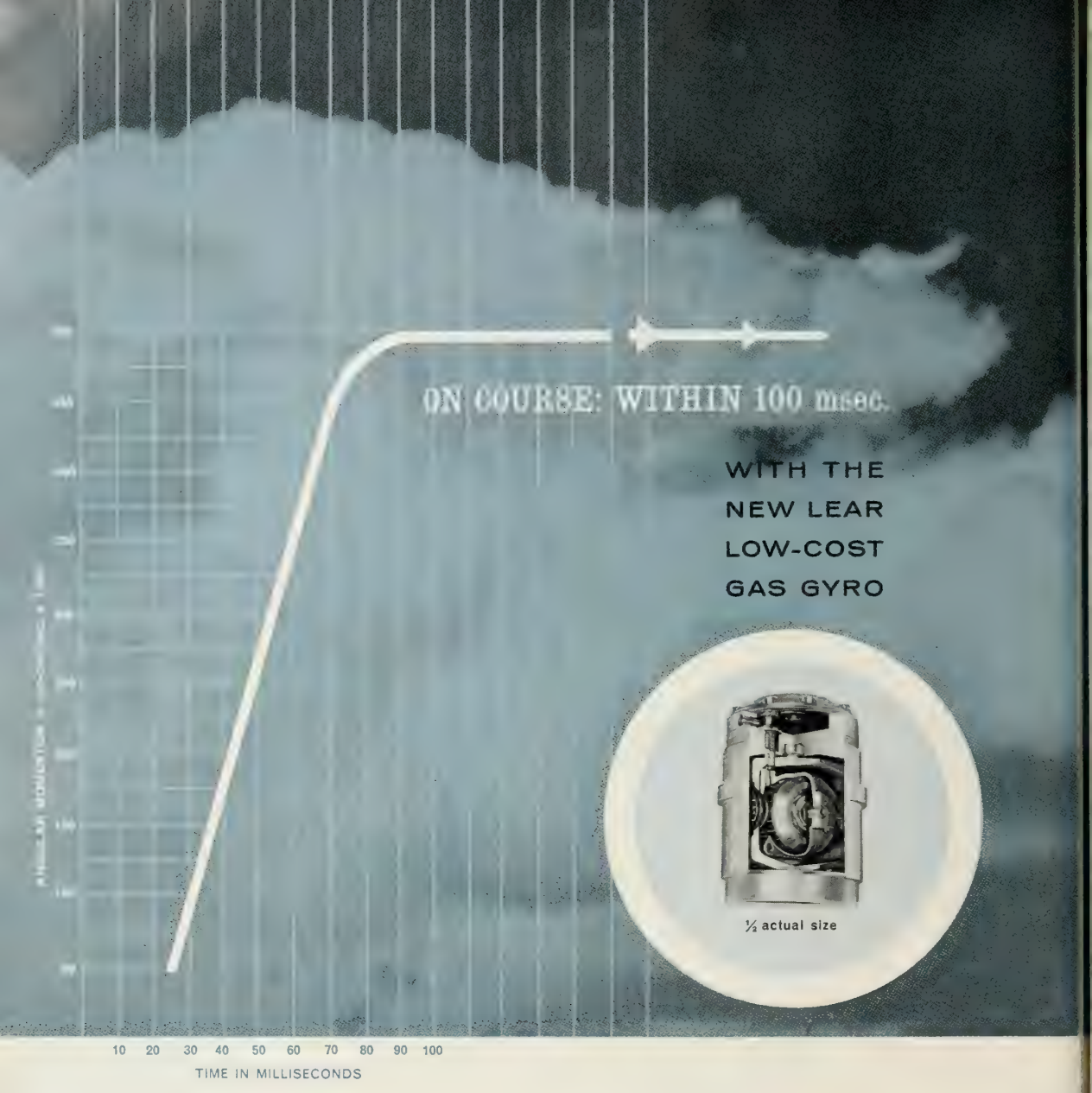
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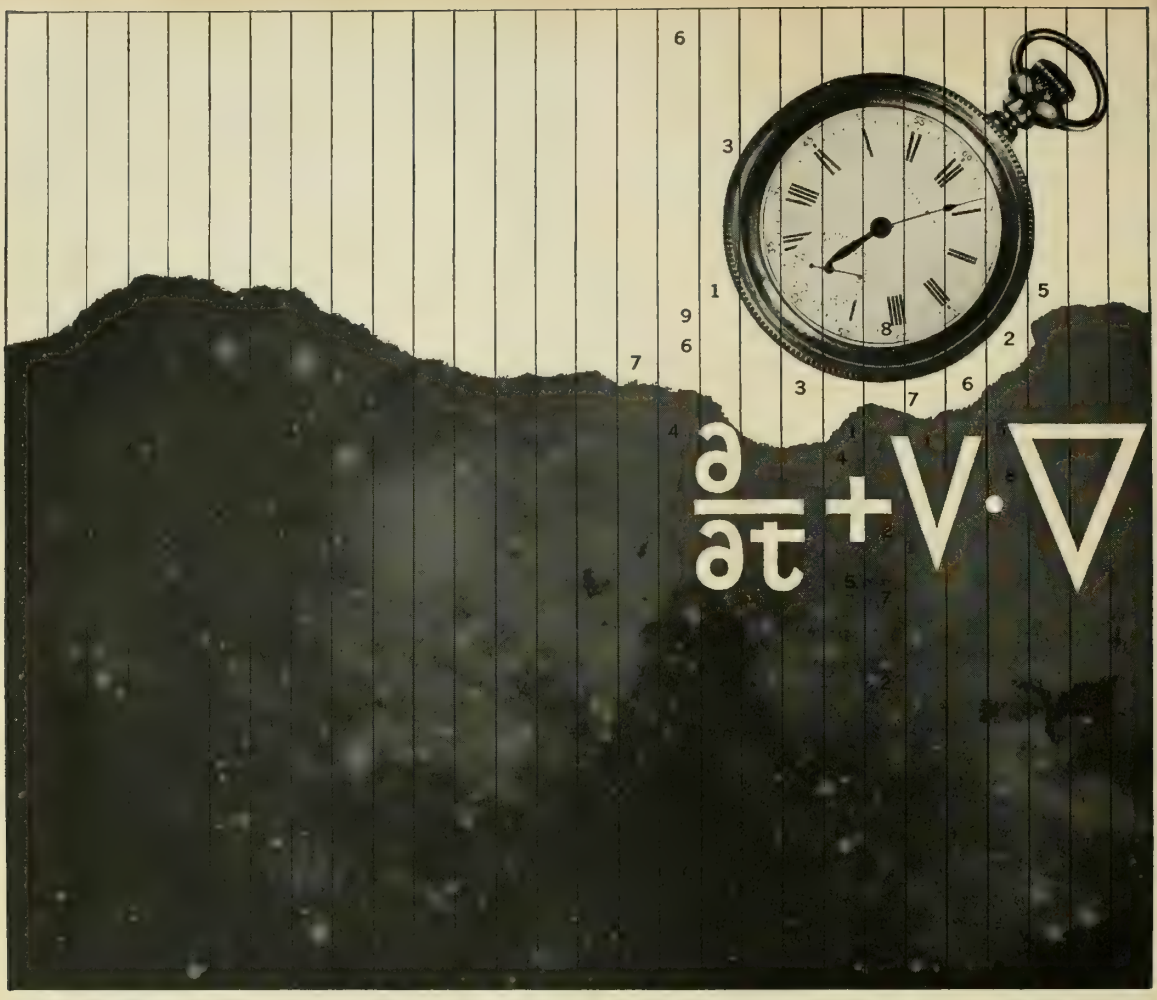
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THE WEEKLY OF SPACE SYSTEMS ENGINEERING

missiles and rockets

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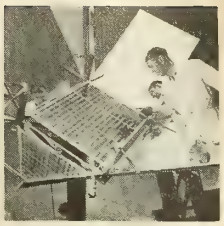
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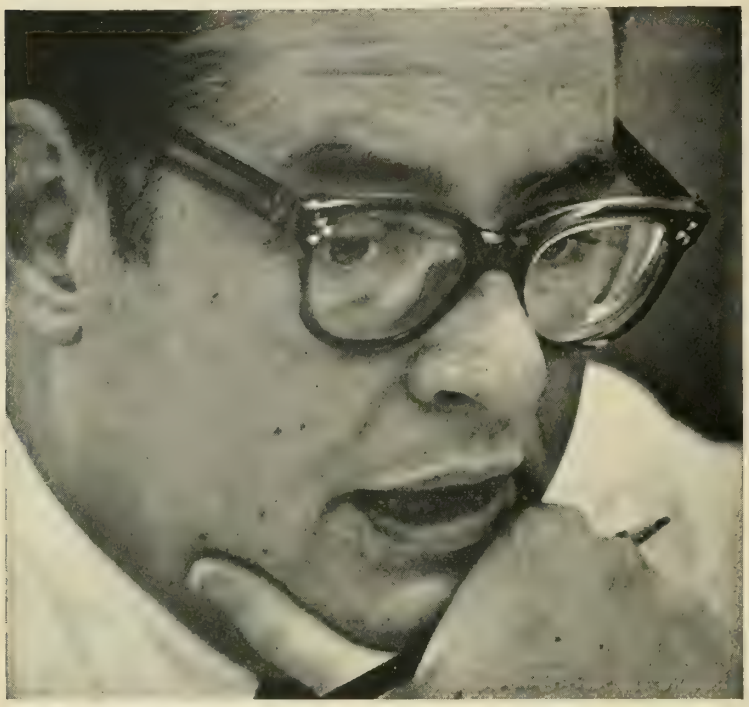
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Engineers familiar with programming, operations, and instrumentation for ballistic missile flight test.

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—letters—

More Titov Reaction

To the Editor:

I read with much interest, pleasure and agreement your May 14 editorial ("Go Home, Russian.").

Without a doubt his visit was a flop, and he had very little influence on the American people, other than unfavorable.

His appearance with Glenn on TV was a revelation to the public. The extreme difference between the two men—in mental level, personality, manners and knowledge—was enough to make a 12-year-old student realize the difference. The poor senile Russian scientist seemed more like a tired, aged actor reciting oft-spoken lines.

The discrepancies between the reports of Titov's orbital flight effects on his body is amazing. The scientist, the professor and Titov do not agree. Titov's denial of any unpleasant effects during orbit or five days after contradicts the medical reports.

The worst thing is that he will never admit to the greatness of America, the hospitality he received and the type of people he met. He will return to Russia and recite his falsehoods, distortions and misconceptions like the well-trained Communist.

Emmett M. Ford
Wichita, Kan.

To the Editor:

I feel your editorial expresses the feelings of quite a few of the average "Joe Americans." How many times can we roll out the red carpet for a slap in the face? Are we extending the arm of friendship far enough, or only far enough to break it?

Any attempt on our part to bridge the gap has, as you say, resulted in patronizing propaganda. Why not take the monies spent on wining and dining these so-called bearers of friendship and spend it on some "American propaganda" to try to enlighten the people behind the curtain of fear and dispel some of the feelings of superiority and hatred toward us?

Thelma Peterson

To the Editor:

I agree with you one hundred percent.

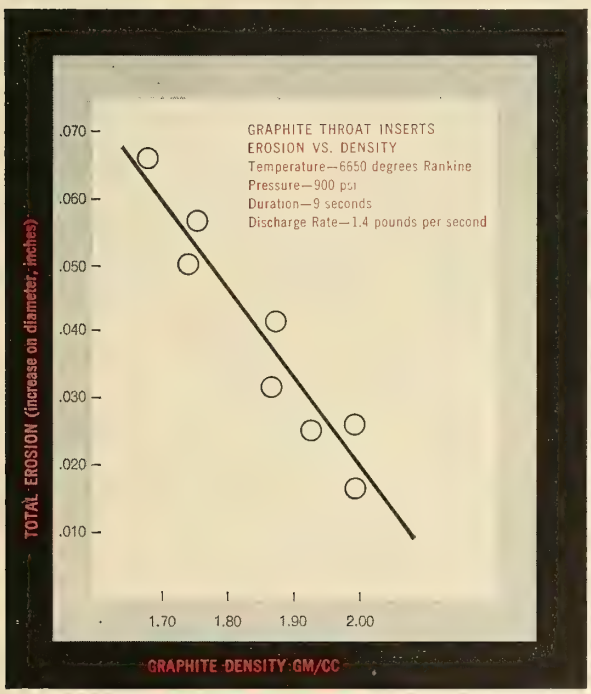
I heard Mr. George B. Dewey, editor of Survival Press Associates and an international news correspondent, make the statement recently that our intelligence agents inside Russia know that three Russian Astronauts lie buried in Moscow and another, a woman, is missing. He also stated that Gagarin's famous flight consisted of jumping out of a high-flying jet plane and descending in a parachute.

Mr. Dewey claims our State Dept. knows this but is keeping quiet so not to make Khrushchev mad.

When are we going to start letting the American people know the truth—that the Russians are not nine feet tall?

Ray C. Webster
Santa Cruz, Calif.

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EROSION VERSUS DENSITY AHDG is an extruded base high density graphite (1.90 gm/cc minimum) processed for both maximum thermal shock resistance and exceptional physical properties. The plot above shows an erosion vs. density curve. The data was obtained in a test firing series at Rohm and Haas Redstone Arsenal Division, Huntsville, Alabama. All conditions, including graphite properties, were held constant with the exception of density. The importance of high density as a property of a graphite which must operate in a rocket motor exhaust environment is clearly evident.

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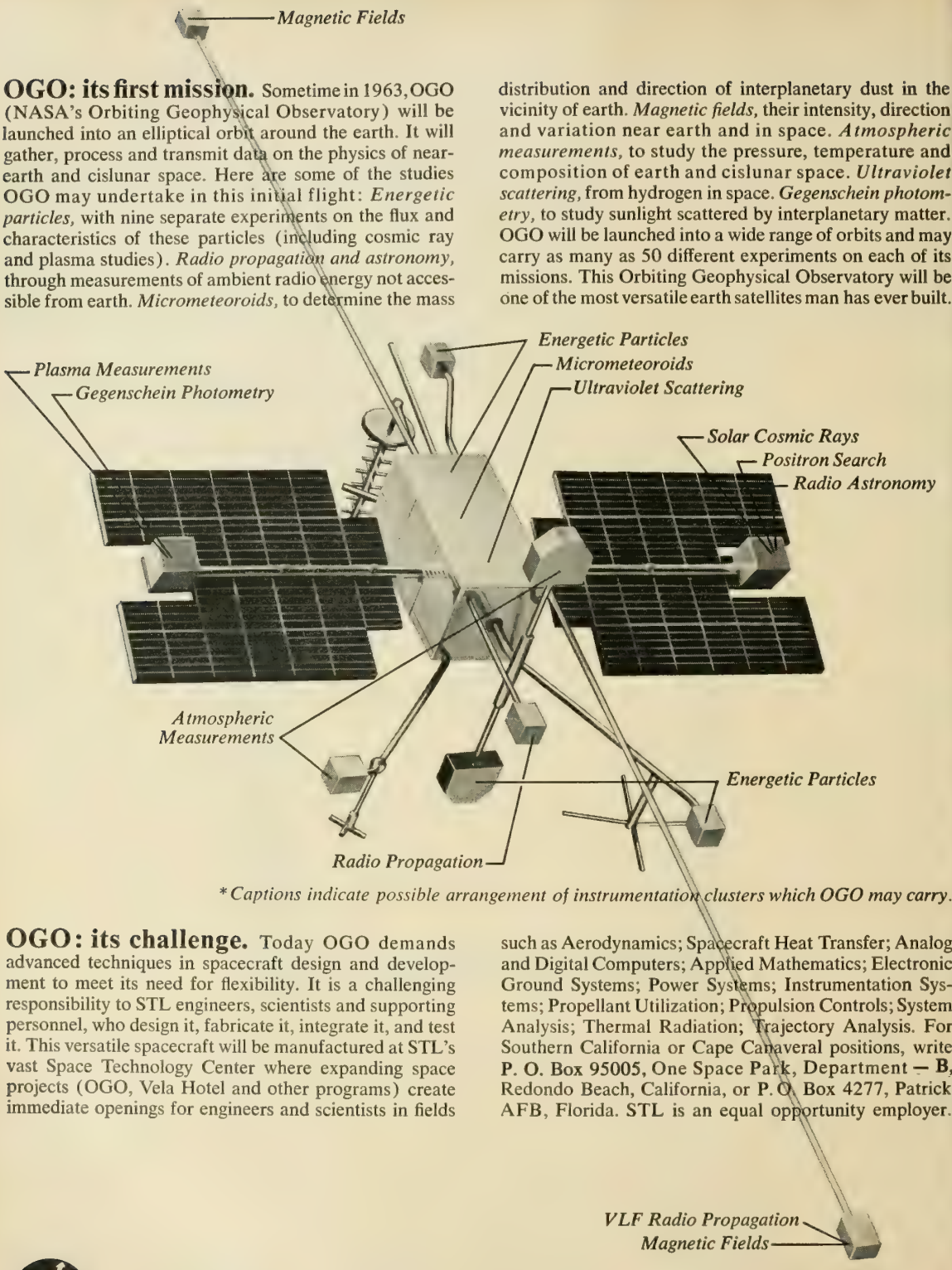
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OGO: its first mission. Sometime in 1963, OGO (NASA's Orbiting Geophysical Observatory) will be launched into an elliptical orbit around the earth. It will gather, process and transmit data on the physics of near-earth and cislunar space. Here are some of the studies OGO may undertake in this initial flight: *Energetic particles,* with nine separate experiments on the flux and characteristics of these particles (including cosmic ray and plasma studies). *Radio propagation and astronomy,* through measurements of ambient radio energy not accessible from earth. *Micrometeoroids,* to determine the mass distribution and direction of interplanetary dust in the vicinity of earth. *Magnetic fields,* their intensity, direction and variation near earth and in space. *Atmospheric measurements,* to study the pressure, temperature and composition of earth and cislunar space. *Ultraviolet scattering,* from hydrogen in space. *Gegenschein photometry,* to study sunlight scattered by interplanetary matter. OGO will be launched into a wide range of orbits and may carry as many as 50 different experiments on each of its missions. This Orbiting Geophysical Observatory will be one of the most versatile earth satellites man has ever built.



** Captions indicate possible arrangement of instrumentation clusters which OGO may carry.*

OGO: its challenge. Today OGO demands advanced techniques in spacecraft design and development to meet its need for flexibility. It is a challenging responsibility to STL engineers, scientists and supporting personnel, who design it, fabricate it, integrate it, and test it. This versatile spacecraft will be manufactured at STL's vast Space Technology Center where expanding space projects (OGO, Vela Hotel and other programs) create immediate openings for engineers and scientists in fields such as Aerodynamics; Spacecraft Heat Transfer; Analog and Digital Computers; Applied Mathematics; Electronic Ground Systems; Power Systems; Instrumentation Systems; Propellant Utilization; Propulsion Controls; System Analysis; Thermal Radiation; Trajectory Analysis. For Southern California or Cape Canaveral positions, write P. O. Box 95005, One Space Park, Department — B, Redondo Beach, California, or P. O. Box 4277, Patrick AFB, Florida. STL is an equal opportunity employer.

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The Countdown

WASHINGTON

New West Ford Launch Set

Air Force plans to launch another *West Ford* experiment this month. The communications experiment—to place a band of copper dipoles in orbit—will be modified to include use of a ground device for release of the needles after orbit determination. Primary purpose: to insure that the dipole belt will be in an orbit of limited duration. Despite this, further scientific protests are expected, particularly if the experiment is kept secret because of its piggyback ride aboard a *Midas* satellite.

Heavy Launch Schedule for NASA

NASA has another heavy launch schedule over the next three months. *Tiros V* is slated for mid-June. It will be followed by the first *Telstar* shot in July. A material re-entry test with a *Scout* booster and two Venus fly-by shots with the *Mariner R* spacecraft are set for July and August.

More Freedom for NASA

NASA will have new flexibility in its construction of facilities under the Fiscal '63 space agency authorization. The agency will be permitted to transfer three percent of its total $2.9-billion research and development budget to construction items. Another $30 million of its $800-million construction budget also may be transferred between projects.

Exemption for Project Orion

Any nuclear test ban agreement between the U.S. and the Soviet Union probably will exempt Project *Orion*, the Air Force project for propelling space vehicles by means of small nuclear charges. That's what AF and Atomic Energy Commission officials are telling Congress. They are comparing *Orion* to the AEC Plowshare program, pointing out that it is not a weapons program.

No More NASA Budget Cuts Seen

Word from the Hill: The Senate Space Committee will make no further reductions in the NASA Fiscal '63 authorization bill of $3.67 billion, already overwhelmingly approved by the House. Whether the Senate committee restores any of the $116 million cut by the House will depend on how hard NASA fights for the funds, according to committee sources. The Senate committee's open hearings will start in mid-June.

How Do You Find Them?

Navy has had difficulty tracking plastic-hulled submarines even with the most advanced detection gear. In one test, a free-flooded two-man sub ran undetected on a pre-plotted course known to the searchers. It passed within 500 yds. of the search vessel at a depth of 70 ft.

An Exit from Gemini

Consideration now is being given to the possibility of having one or both crew members of the *Gemini* capsule leave the vehicle during orbital flight. They would move around outside the capsule only briefly. Most likely maneuver: One man will go outside on the end of a lifeline for simulated tasks while the other monitors his performance.

Polaris A-3 Firing Set

First flight test of the *Polaris A-3* from Cape Canaveral is set for July. Both stages of the 2500-mi.-range sub-launched missile are glass-wound.

INDUSTRY

High Thrust for Titan II

Aerojet-General has static-fired a single YLR 91-5 *Titan II* storable engine at 262,000 lbs. thrust. A pair of the engines has been static-tested at 425,000 lbs. thrust. Both figures are well above announced ratings for the engines.

First Firing for Douglas S-IV

First static firing of the Douglas-built *Saturn S-IV* stage is scheduled for this month at the firm's Sacramento, Calif., test facility. The hot firing of the six Pratt & Whitney RL-10A3 engines follows extensive cold flow and chilldown tests. A steam evacuation system capable of simulating 13-mile altitudes will be employed during the test.

Study Contract for 360-in. Rocket

Aerojet-General holds NASA study contracts for 280-in. and 360-in. boosters and an Air Force study contract on a 160-in. motor.

INTERNATIONAL

Gagarin Boasts of Spaceship

Soviet Cosmonaut Yuri Gagarin told a Japanese audience last week that Russia is constructing a giant spaceship capable of taking several men into space. He declined to give a launch date.

Aussie Payload for U.S. Rocket

Australia's Commonwealth Scientific and Industrial Research Organization will provide a scientific payload to be placed into orbit by a U.S. rocket. An early test of the equipment, designed to study effect of the Sun on radio communications, will be made with an *Aerobee* launched at Wallops Island this year.

Corporals on Hebrides Range

Seven battalions of U.S. Army troops equipped with the *Corporal* missile are scheduled for firings on the British missile range in the Hebrides between June and August.

More Pacific Tracking Stations

Agreement is expected within a month on the establishment of U.S. tracking stations on Manus in the Admiralty Islands and on Buka in the Solomons. Negotiations between Australia and the U.S. on these have been under way for a year.

F-1 Gets First Full Test

The U.S. space program passed a major milestone with the first full-thrust, full-duration firing of the giant F-1 engine.

NASA called the test "completely successful." "We're beginning to move again," declared A. O. Tishler, director of Propulsion in the space agency's project *Apollo* program.

The May 26 static test was conducted at Edwards AFB, Calif. The free world's biggest rocket engine burned for 151.8 seconds and developed a thrust of over 1.5 million lbs. Both marks were above the engine's specifications, which call for a burning time of 150 seconds and a thrust of 1.5 million lbs.

Major result of the test, according to Tishler, was its proof of the engineering feasibility and correctness of the F-1.

It did little, however, to erase the current delay of several months in the engine's preliminary flight rating test (PFRT). As a result, there is good possibility that the F-1-powered *Advanced Saturn* Booster will not be ready for flight-testing until late 1965.

Preceding the recent test, the F-1 had been fired more than 300 times at less than its programed capability.

Tishler said at least another year's testing lies ahead before its PFRT can be completed. Two more years of engine qualification will follow before the first *Advanced Saturn* with 7.5 million lbs. thrust is flown. A lengthy flight-test program could defer the first manned payload missions of the *Advanced Saturn* until late 1966 or early 1967.

It is now expected that the F-1 will not complete preliminary flight rating test before the latter half of 1963. Besides many more full-duration, full-thrust firings, two other major tests are scheduled.

One will involve a full-thrust-and-duration firing with gimballing of the engine.

The other involves a test of an extended nozzle which the flight versions of the engines will require. The engine now being tested has a short nozzle. The gimballing test probably will be made in the next two months, the extended nozzle firing in about six months.

Shots of the Week

Cosmos V—termed "a routine artificial Earth satellite" by the Soviet TASS news agency—was launched May 28.

The new satellite, the Soviet announcement said, was launched at an inclination of about 49 degrees and has a period of 102.75 minutes with an apogee of 933 miles and a perigee of 126 miles. "All systems are functioning normally," Tass said.

In other firings:

• An *Aerobee* sounding rocket carrying a 213-lb. scientific payload was launched 125 miles into the atmosphere on May 25 and later recovered from the ocean by a helicopter.

The payload included experiments to compare electron density and temperature during daylight with data previously gathered at night; study and record effects of meteors striking a smooth surface; gather cosmic ray data and test cadmium sulphide cells for a future micro-meteoroid satellite launching.

• A full three-stage test of the Army's *Nike-Zeus* antimissile missile was successfully conducted at PMR, Pt. Mugu, Calif., May 26.

DOD Sets Up Advisory Unit

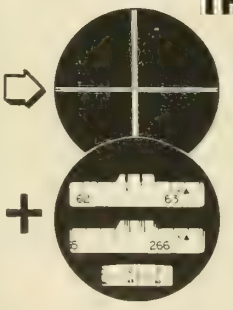
A new Defense Industry Advisory Council to "provide the Secretary of Defense and his principal management assistants a forum for presentation of logistics management objectives, problems and accomplishments" was established last week.

Although no representatives from industry have yet been named, the Council is expected to hold its first meeting sometime this month. Deputy Secretary of Defense Roswell Gilpatric will head the new group and Assistant Defense Secretary (Installations & Logistics), Thomas K Morris will be his alternate.

The Advisory Council will number 15 to 25 industrial representatives.

A "focal point" for DOD-Industry discussions, the Council is expected to supersede to an extent industrial

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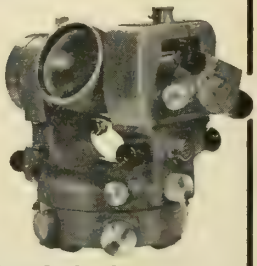


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associations which, according to Gilpatric, have resulted in "considerable duplication of time and effort by individuals representing the Defense Department and industry."

Specifically mentioned as due for probable downgrading were; National Security Industrial Association, Aerospace Industries Association, Electronics Industries Association, "various defense committees" of the U.S. Chamber of Commerce, National Association of Manufacturers and the Auto Manufacturers Association.

Under the regulations of the Advisory Council, Gilpatric said, industry representatives will be named from specific firms rather than from industrial associations.

M/R Editor Named AWA President

William J. Coughlin, editor of MISSILES AND ROCKETS, was elected president of the Aviation/Space Writers Association on May 25 at the association's annual meeting in San Francisco.

Other officers: Edward Pickering, *Flight* magazine, Dallas, Tex., first vice president; George Carroll, New York *Journal-American,* second vice president; Don Fairchilds, Ryan Aeronautical, third vice president. Incumbents Les Spencer, treasurer, and Ralph McClarren, secretary, were re-elected.

The Robert S. Ball Memorial Award went to Edwin G. Pipp, aviation editor of the *Detroit News.* The award, presented for the first time this year, was donated by Chrysler Corp.

The James J. Strebig Memorial Award went to Editor Tony Page of *Cross-Country News.* Other awards went to Mel Hunter, Kenneth F. Weaver, Don Downie, Tom Turner, Herb Fisher and Richard Larrick.

Larrick, of United Technology Corp., was honored for outstanding public relations work.

Navy Sets Up Satellite Unit

The Navy Astronautics Group—established at PMR Headquarters, Pt. Mugu, Calif., recently as the Navy's first space satellite command —will operate the *Transit* navigational satellite system within the Department of Defense.

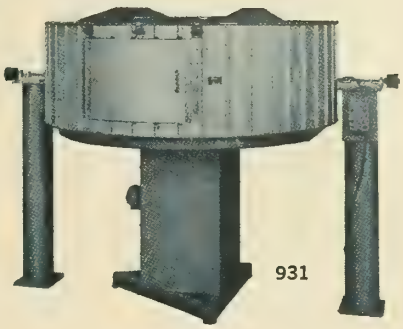
In addition, the new Astronautics Group will maintain and operate other space systems assigned by the Chief of Naval Operations.

Ultimately, the Command will include a satellite command and injection station, computer center, operations control center and satellite

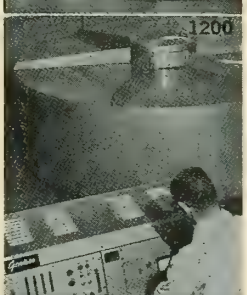
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tracking facilities at Mugu. Other tracking facilities under the Group will be located in Maine, Minnesota and Hawaii. All will be concerned with the operational *Transit* system.

High-Altitude Tests Due

Operation *Dominic*—the U.S. nuclear test series in the Pacific—was slated to move into its high-altitude test phase last week.

Three, and possibly four tests, at altitudes ranging from "tens of kilometers" to about 600 miles out in space are expected to be conducted. The nuclear devices will be launched to altitudes by a *Thor* booster, according to Pentagon sources.

Designed to provide data on the effects of high-altitude nuclear explosions, the tests should provide valuable information for the development of an antimissile missile.

The nuclear tests include:

—A sub-megaton device exploded at "tens of kilometers."

—A megaton device at "hundreds of kilometers up."

—A sub-megaton device at about the same altitude as the second.

—A fourth test of undisclosed power at an intermediate altitude, depending on the results of the first three.

Titan Explosion Probed

AF officials have begun investigating the causes of an explosion of a *Titan I* silo and missile on May 24 at Beale AFB, Calif. The probe is also to include an evaluation of the *Titan* operational procedures.

The explosion—hospitalizing seven and slightly injuring 52 others from smoke inhalation — occurred during a LOX de-fueling operation by Martin Co. technicians. Cost of the loss of the silo and missile has been estimated at $20 million by Defense officials.

Not yet operational, the Beale AFB *Titan* complex consists of a nine-missile, three-by-three-squadron in which the missiles are raised to the surface before firing.

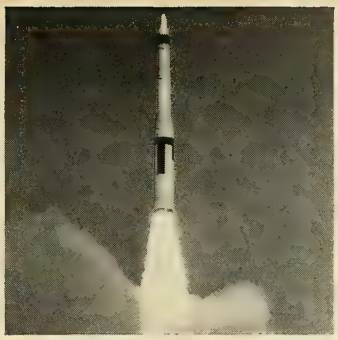
The other two launchers in the complex, their missiles and the control center were not damaged.

Meanwhile, the AF announced last week that more than 100 *Minuteman* sites will probably be relocated to comply with the ruling of an Armed Forces Explosives Safety Board.

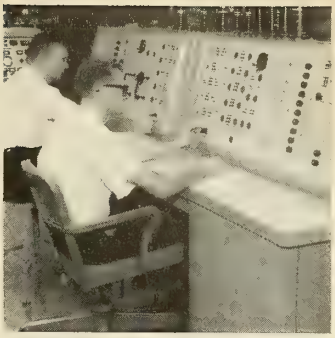
The ruling—upheld by the Defense Department—said that the sites must be at least 1200 ft. from civilian dwellings or places of assembly. Until the new ruling, the AF had used a safety distance of 650 ft.



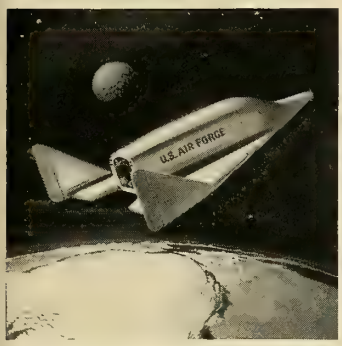
Weapon system management: BOMARC



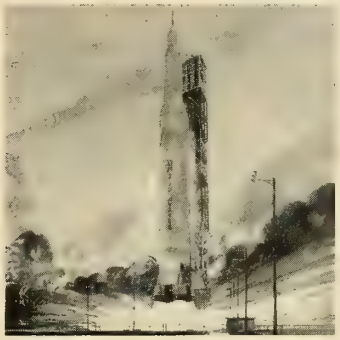
System integration: MINUTEMAN



Electronics engineering and manufacture



System contractor: DYNA-SOAR



Space booster development: SATURN S-IC



HYDROFOIL development, construction



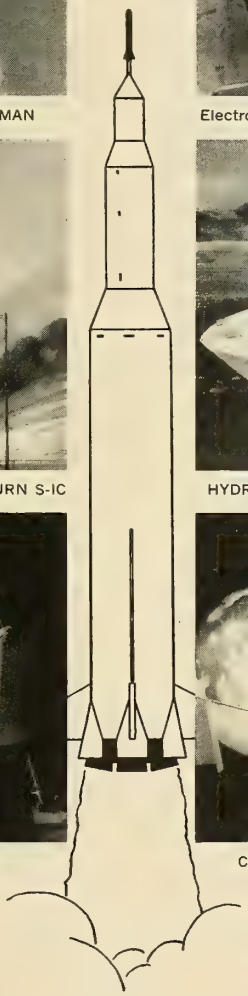
Space medicine research



Satellite control research



Counter-moon research vehicle



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AERO-SPACE DIVISION

2nd-generation booster . . .

156-in. Glass Case Award Near

NASA request stirs industry interest; appeal is in low cost, light weight of filament windings

by John F. Judge

THE FIRST STEPS towards development of an economical large solid-rocket booster for future space exploration are under way at NASA's Marshall Space Flight Center.

Quotations on a contract to determine the feasibility of large, filament-wound, solid motor cases are presently being evaluated at Huntsville.

The RFQ's, due June 4, cover the design, fabrication and testing of two 156-in. glass fiber motor cases, each 400 in. long. The contractor will dynamically test a case and then hydrostatically destroy it.

A second part of the request deals with the loading and firing of a filament-wound chamber and then hydrostatically testing it to destruction.

It is likely that the loading and firing section of the contract will be substantially altered or eliminated entirely—even though it constitutes an ideal test for any pressure vessel.

Bid invitations were sent to Thiokol, Aerojet, United Technology, Lockheed, Rocketdyne, Boeing, Allison Division of General Motors, Rohr, Goodyear Aircraft, U.S. Rubber, H. I. Thompson, Hercules Powder, Douglas, Bendix, Brunswick, Lamtex, Black Sivalles & Bryson, Universal Molded Fiberglass Products and Owens Corning Fiberglas. Douglas reportedly will not bid.

• **Expanding the art** — The NASA move is best described as an attempt to expand the state-of-the-art. Glass cases are considerably cheaper than comparable steel ones and afford a definite weight savings. In addition, complex heat treating procedures are avoided. But filament winding has not yet been applied to such large vessels although a few firms are very close to this stage of development.

If the propellant loading and firing clause is kept in the contract, it is probable that one of the major solid propellant firms will be involved. It is quite likely that such a firm will win even if the loading requirement is dropped.

Hercules Powder, Aerojet and United Technology have known capabilities in the winding area. While Thiokol may not have an extensive in-house ability, the firm has close ties with several winding outfits. All are bidding, or have evinced "interest" in the Marshall request.

A large filament-wound solid booster represents a "second generation" vehicle since metals will probably be used in any large booster work funded in the near future.

NASA is beefing up its solid propulsion group at Marshall. The Solid Propellant Section of the Propulsion and Vehicle Engineering Division's Propulsion and Mechanics Branch will monitor the filament-wound case feasibility contract when let. The Marshall Center has an extensive group in structures capable of aiding in the evaluation. A contractor selection is scheduled for the latter part of June. ¤

Air Force Expects to Have Big Solid Program Going This Fiscal Year

NASA REQUIREMENTS for large solid rocket motors have been clearly outlined to the Defense Department and a top DOD official says there should be requests for proposals "before the end of this fiscal year."

In a letter from Dr. Robert C. Seamans, Jr., NASA Associate Administrator, to John H. Rubel, Deputy Director Defense Research & Engineering, dated Feb. 16, 1962, the space agency clarified its view of Nova-*class solid-propellant motors.*

"NASA has a strong interest in the technology of solid-propellant rockets," the letter said, "and hopes to make use of them in NASA vehicles when the appropriate feasibility is demonstrated."

Specifically, the Seamans letter said NASA is interested in motors with thrust levels of "about 2.5 million and 5 million lbs. and burning times of approximately 115 seconds."

"The higher thrust level produced by motors about 240 inches in diameter by about 100 feet long," Seamans pointed out, "is especially attractive from a long-range, payload growth viewpoint. In addition, the greater thrust and impulse per motor results in designs with fewer motors per stage, and thus with greater potential for reliability."

In order to establish the feasibility of the 240-in. motor, NASA feels that these basic tasks must be accomplished:

—Demonstration that a very large amount of propellant (over 2 million lbs.) can be cast into a single, nonsegmented motor, and that the monolithic charge can be qualified, ignited and burned properly.

—Demonstration that the inert components of the motor case and nozzle can be made in flight-weight design, transported to the motor manufacturing plant, and assembled into the complete motor with adequate reliability.

—Demonstration that a complete motor of this weight and dimensions can be handled and shipped by the proposed water handling technique.

• **AF Following Up**—*Since receipt of the Seamans letter, Gen. Bernard A. Schriever told the House recently, the Air Force has been working with NASA "to bring our requests for proposals to industry in line specifically with what they want in the large solid area."*

As a result of these discussions, the Air Force expects "to have a program for a large solid, beyond the 120, actually under way before the end of this fiscal year," Schriever added.

But he declared that once the feasibility of the large solid rocket motor is proven, the "responsibility and authority" to develop a Nova-*class solid-rocket vehicle will rest with NASA.*



by Frank G. McGuire

NASA Considers Six-Orbit Mission For MA-8 Flight

Decision due in about a month; seven-orbit flight plan dropped for safety reasons; an account of the Aurora 7

CAPE CANAVERAL—NASA officials—in the wake of the relatively successful *MA-7* manned space flight—are now considering a six-orbit shot for the next Project *Mercury* mission.

If approved, the flight would be attempted in the August-September period. It would be followed by an 18-orbit mission early in the first quarter of 1963.

A final decision on the extended 9-hour-long *MA-8* mission will be made in about a month. It will hinge on a complete evaluation of telemetry data obtained during the second U.S. manned space flight on May 24.

NASA officials expect the six-orbit flight to be approved. Only an unexpected telemetry indication of serious malfunction in the *Mercury* capsule during *MA-7* could scrub it.

The most serious problem during the Scott Carpenter flight—the loss of fuel in the attitude control system—has been blamed on "pilot error." Space agency officials said excessive amounts of the hydrogen peroxide were used because Carpenter inadvertently used both the manual and automatic control systems.

One major problem still unexplained is why the retro rockets failed to bring the capsule down into the planned landing area in the Atlantic.

Since the retros have worked perfectly in three previous manned *Mercury* missions, this should not affect *MA-8*.

SMOOTH takeoff of Atlas on Pad 14, taking Carpenter on his three-orbit trip. Launch itself was uneventful.

• **Six-hour safety limit**—Consideration of the six-orbit flight was revealed to MISSILES AND ROCKETS by Charles W. McGuire, director of Project *Mercury* in NASA's Office of Manned Space Flight.

Earlier, NASA had studied a seven-orbit 10-hour *Mercury* mission (M/R, April 23, p. 15).

It was dropped, McGuire said, because it would stretch the *Mercury* capsule capability to the danger point and would leave little flexibility in an emergency.

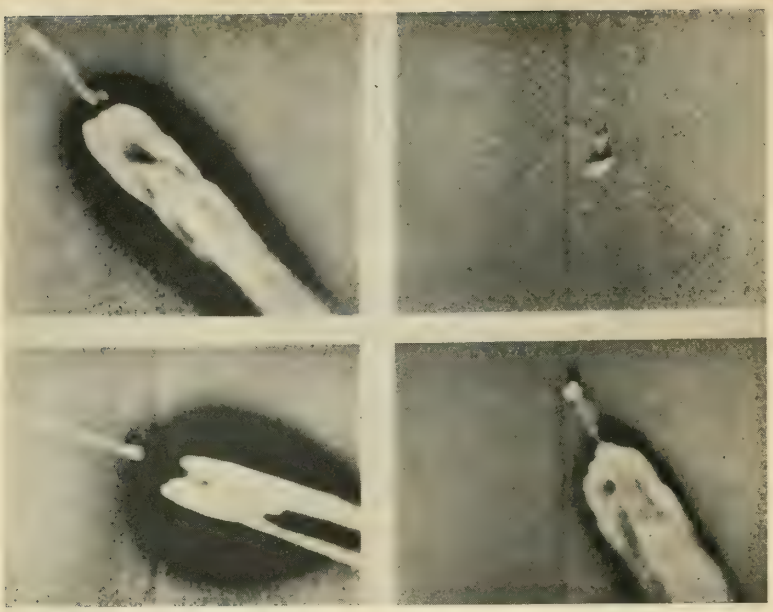
The NASA official said that the extended *MA-8* mission would not involve any changes in the capsule equipment. However, major changes will be made in the mission flight plan in order to conserve fuel and electric power supplies.

The flight plan will call for at least three orbits—six if all goes well. NASA officials will let the spacecraft drift for 1½ of the first three orbits. It will also be allowed to drift during the fourth and part of the fifth orbit.

During the three-orbit drift period, all control systems will be shut down to conserve fuel.

The space agency also plans to give the astronaut less to do during the mission. The number of experiments will be reduced because the pilot has to use the control system while conducting them.

• **Modifications**—One minor change—planned for the 18-orbit one-



PHOTOS taken with unique TV-telescope camera show Aurora 7 climbing atop Atlas (top left), starting to program downrange (top right), separating (lower left) and on its own.

day flights—will also be incorporated into the six-orbit mission. The deadband time in the attitude control system will be extended.

This will permit the capsule to drift further off position before the automatic control system is activated.

The long drift period and shutting down of the control system will reduce the battery power consumed, because scanners and other electrical systems will also be shut down.

It is possible that the capsule's periscope will be removed. This would provide room for more attitude-control system and batteries. The modification will be made for the 18-orbit mission, and the change could be incorporated into *MA-8*.

The present environmental control system in the capsule provides enough oxygen for a 6½-orbit flight. More water may be added to the system, however.

Impact point for the extended flight will be northwest of Midway Island in the Pacific. Control point for the recovery forces will be off the Philippine Islands.

McGuire said only a few more ships will have to be added to the recovery forces, but a big increase will be required in the number of airplanes used. This is necessitated because more contingency recovery areas will have to be covered.

A new tracking ship will be added to the *Mercury* network for the six-orbit mission. The Rose Knot, formerly the Atlantic Ocean tracking ship, has recently been given a command capability in a Baltimore shipyard by the Bendix Corp. Outfitting has been completed and equipment tests are being run. The ship will move to the Pacific well before the scheduled *MA-8* flight. It will also be used as the Pacific Ocean tracking ship during the 18-orbit missions.

No astronaut has been selected for the next *Mercury* shot, but the likely choice is Carpenter's backup pilot, Walter S. Schirra. Astronaut Donald Slayton is scheduled to undergo a new examination to determine if the slight heart disorder which caused his removal as the *MA-7* pilot has cleared up. If so, he will again be in the running.

NASA officials hailed the *MA-7* flight with Scott Carpenter at the controls as a success. Carpenter orbited the earth three times swinging from a high altitude of 167.4 miles to a low of 99 miles. The orbital period was 88.3 minutes.

• **Familiar problems** — Major and minor bugs—some of which have been plaguing the *Mercury* Project in almost every flight—developed.

Attitude control, parachute deployment, temperature control and instrument reliability will continue to be prime areas of concentration by NASA trouble-shooters.

On the flight of Enos, the control system and the temperature system were functioning improperly for a time. On Glenn's mission, the attitude control system, the parachute system, and some of the instrumentation were faulty. Most recently, Carpenter had trouble with the temperature-control system, the attitude control system, the reliability of some instrument readings, and the parachute deployment system.

Numerous fixes have been instituted on subsystems within the capsule, but the basic problems seem unresolved.

• **Carpenter mission**—After an exceptionally smooth final countdown beginning at 11 p.m. the preceding night, M. Scott Carpenter was boosted into orbit at 7:45 a.m. EST on May 24. During the countdown, the only technical pause was caused by a bit of noise in the *Atlas* guidance system. This disappeared almost immediately and the count proceeded until just before 7 a.m., when a series of three fifteen-minute holds was begun, to await better visibility through the ground haze. Following another hold of five minutes, the count was resumed and progressed smoothly to liftoff.

Entering an orbit similar to Glenn's, Carpenter at first had no significant problems with his spacecraft. But later minor problems began cropping up.

First was his suit temperature, which rose according to the telemetry readout, but didn't appear to bother Carpenter. At about the same time, he noted that observation out the window showed him to be in a slightly different attitude than was indicated by the instruments.

The Canary Island tracking station, however, said telemetry showed his attitude in orbit to be nearly perfect. Simultaneously, the first mention was made over the *Mercury* network that Carpenter seemed "preoccupied" with something with the result that he failed to copy sunset/sunrise times transmitted to him from the Canary Islands station.

Carpenter was repeatedly warned about over-use of his fuel supply, which was completely exhausted by the end

Sarah Locates Carpenter

AN EXTREMELY SMALL communications device pin-pointed the exact location of the Aurora 7 seconds after it landed in the Atlantic beyond the prescribed recovery area.

Known as SARAH—Search and Rescue and Homing—the British-developed system is manufactured by Simmonds Precision Products, Inc. SARAH has three major components—a radio beacon and power pack located in the Mercury capsule, a receiver installed in the search craft and an antenna on the search vehicle.

SARAH's signals are picked up and visually displayed on the receiver's cathode-ray tube as horizontal blips on a vertical trace. The size and position of the blips indicate to the trained observer the direction and approximate distance to the transmitter.

of the flight. In addition to the fuel-supply problem, the performance of the automatic control system was imperfect. Incorrect attitude of the capsule while Carpenter relied on this system caused him to go manual control, thus drawing his efforts away from scheduled experiments.

Faulty indication of his attitude, apparent faulty indication of his suit temperature, and similar problems were periodically encountered during the flight.

• **Chute troubles** — Upon re-entry into the atmosphere, a supposedly cured problem with the parachute deployment system caused further trouble. Due to severe oscillations in the spacecraft, approaching dangerous proportions, Carpenter manually deployed the drogue chute at 26,000 ft. rather than at 21,000, which the flight plan called for.

Passing through 10,000 ft., at which point the main chute was supposed to deploy, he waited vainly for actuation, then deployed the chute manually at 9500 ft. Whether or not the severe oscillations were caused by the abnormal re-entry has not been determined.

According to the astronaut, the retro firing was far more gentle than he expected, indicating that there might have been a timing error of some type in the triple-rocket retro system.

• **Anxious time** — Impacting upon the water at about 11:41 a.m. EST, Carpenter was some 250 miles downrange from his pre-planned impact area. Some anxiety and confusion occurred when his communications blacked out as expected during re-entry—then remained out as his abnormally long arc into the atmosphere carried him out of range of the *Mercury* communications network, which could indicated that he seemed to be alive but could not communicate with him.

The rapidity with which the capsule passed "out of range" after re-entry and landed in what was a relatively nearby area was surprising to many observers. For nearly an hour there was no definite word on Carpenter's fate, even though he was just off the coast of Puerto Rico. Also, the two ships which were nearest at the time had nothing to do with the *Mercury* program.

• **Rapid data** — At the other extreme, the rapidity with which Carpenter's orbit was confirmed and calculated statistically was surprising. Almost immediately after sustainer engine cutoff (SECO), a confirmation of orbit was forthcoming, followed shortly by apogee and perigee figures.

Communication between the capsule and ground stations appeared to be considerably less than during the *MA-6* flight of John Glenn, and information from *Mercury* Control was also considerably less, leaving some gaps in the general picture of Carpenter's status.

• **Pre-shot snags**—One of the most serious problems preceding the shot was the uncertainty surrounding the actuation system for the parachutes. The three-chute system (drogue, main and reserve parachutes) fell victim to a phantom bug during the Glenn flight—a bug which has not shown itself before. The Northrop system had a near-perfect reliability record until Glenn's flight, when the drogue parachute—which has been described as having a major role in damping out oscillations in the capsule—deployed at 28,000 ft. instead of the planned 21,000 ft.

Seeking an answer, NASA and McDonnell engineers ran tests, never found the cause of the malfunction, but "engineered around it" by installing an additional barostat circuit in the actuation system. This was designed to provide an additional interlock to prevent suspected electrical irregularities from causing premature parachute ejection.

As modified, the system called for manual chute deployment at 21,000 ft., and, if this were not accomplished for any reason, automatic deployment of the drogue at 11,000 feet, then the main parachute at 10,000 ft. As it turned out, the drogue had to be deployed earlier than even manual deployment was scheduled, then the main didn't operate automatically at all.

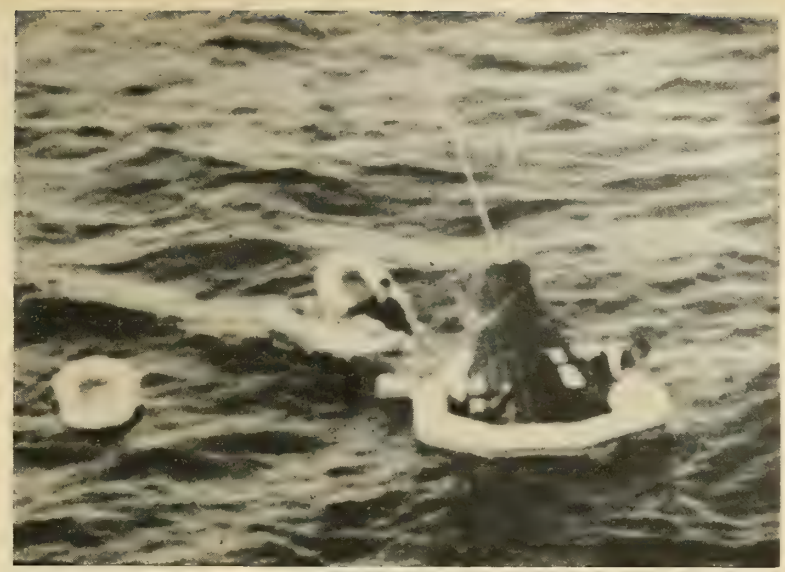
It was the possibility of premature main parachute deployment at altitudes of 15,000 ft. or higher (which would destroy it) that caused NASA most concern and led to the additional interlock. The agency now insists that the drogue is not really a vital part of the recovery system, although it is a desirable one.

The new barostat circuit is said to be an engineering change applying to all *Mercury* capsules, not merely a temporary fix. It is not yet known what action will be taken as a result of Carpenter's experience.

(A second, less serious technical problem arose due to an irregularity in the temperature-control system of the *Atlas* flight control system. It was disassembled, replaced, and re-tested in a short time.

(The styrofoam insulation protecting the *Atlas* fuel tank bulkhead, which

(Continued on page 36)



AIR FORCE pararescue personnel of the 41st Air Rescue Squadron complete fastening of flotation collar to support Aurora 7 following its delayed recovery.

By following the directions indicated on the receiver, the search plane can zero-in on the beacon to within a few feet of its actual location. The SARAH system, in modified form, is standard equipment aboard the Mercury capsules. The beacon is actuated at 10,000 ft. during the descent and continues to function while the capsule is floating.

The famed chimpanzee Ham was located with the device.

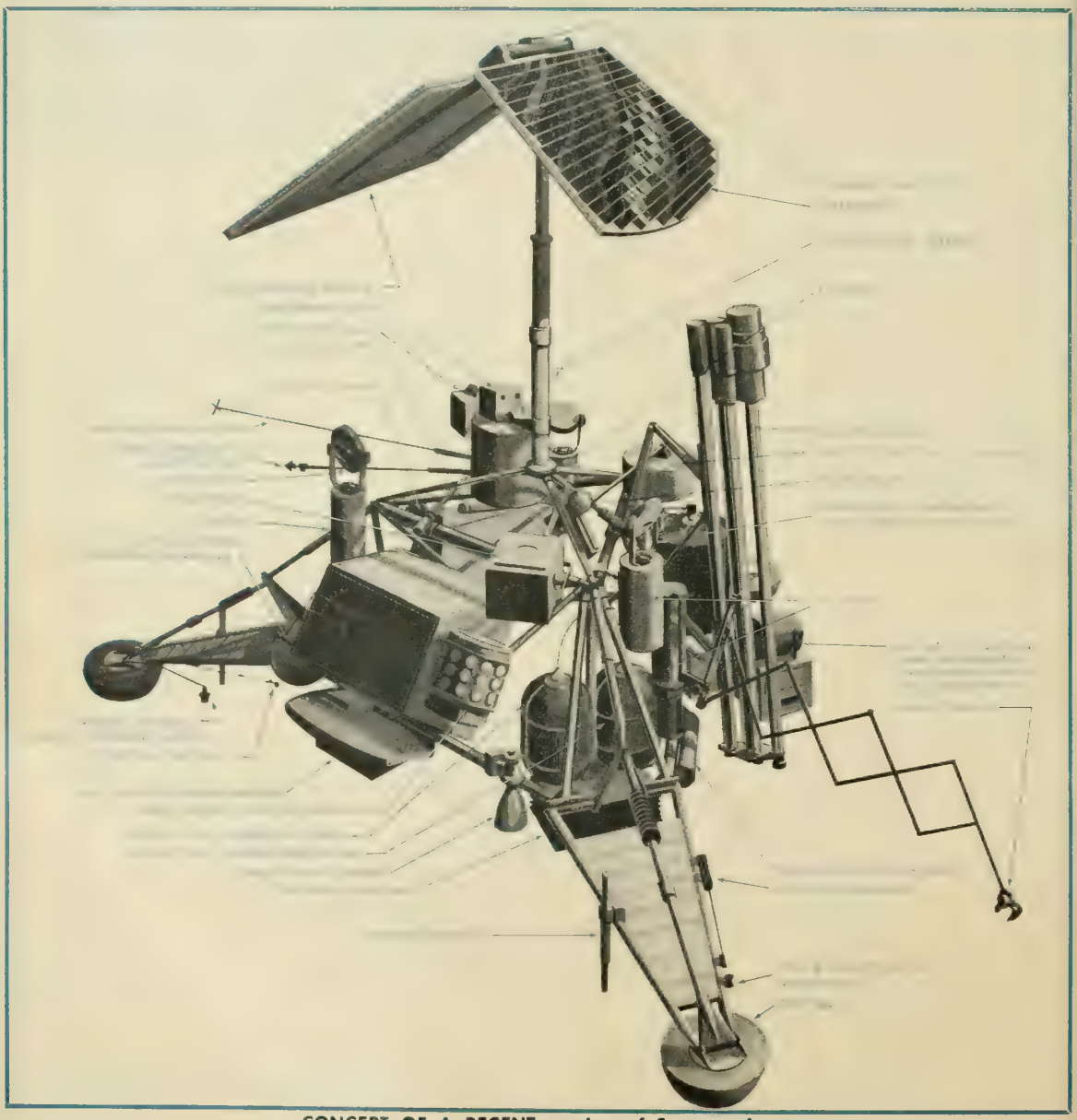
The system also has enjoyed considerable success in the recovery of nose cones, instrument capsules and reentry experiments involving camera pods and data cassettes. A personnel version is standard equipment with the Royal Air Force and several U.S.A.F. commands are procuring it.

SARAH was developed by Ultra Electronics Ltd. of London, which reports it has had inquiries from the Soviet government.

Oversophisticated?...

Twelve Surveyors Now Planned for Moo

Despite criticism of program, aggravated by secrecy imposed, seven 'A's, five 'B's are planned; a report on the instrumentation



CONCEPT OF A RECENT version of Surveyor A.

Exploration

by William Beller

DESPITE pressure in the House of Representatives to push *Prospector* into the *Surveyor* program, officials at the National Aeronautics and Space Administration say they will keep *Surveyor* as it is.

To satisfy House critics, however, NASA is changing *Prospector* into a logistics supply vehicle to support the manned lunar space-flight program. In this way, the agency feels it will be able to put the now unfunded *Prospector* program into the Fiscal 1964 budget—and possibly in the Supplemental Fiscal 1963.

It is likewise possible that the Senate will restore the *Prospector* funds cut out by the House earlier this month.

• **Beleaguered**—*Surveyor* has been under fire in technical circles for the past year. Main criticism is that the spacecraft tries to be all things to all men—a scientific laboratory for scientists, and a probe to test out the lunar environment for *Apollo* astronauts. The result is seen as a spacecraft with needless sophistication which jeopardizes the mission's success.

Adding to the severe tone of the criticism is the cloak of secrecy thrown around the scientific details of the project by the program manager, Jet Propulsion Laboratory. Companies engaged on *Surveyor* are not even allowed to give functional descriptions of the scientific instruments they are developing for the spacecraft.

Much of the information in this article came from several necessarily anonymous industry and NASA sources, and from one of a limited set of specifications describing the scientific payload proposed for *Surveyor*.

The two versions of *Surveyor* are scheduled to be launched by an *Atlas-Centaur* in 1964. *Surveyor A* is designed for a soft landing on the lunar surface where the 200- to 300-lb. instrument package will proceed to view and experiment with the lunar terrain and soil.

Surveyor B—an adaptation of *A*—will be put into a near-polar orbit around the Moon where the spacecraft will take television pictures of the body in addition to making radiation and other physical measurements of the environment.

Although a working prototype of *Surveyor A* is expected to be ready for environmental testing this summer, there reportedly will be many empty boxes taking the place of scientific instruments. Reason given is the lag in awarding final contracts for the instrument subsystems.

• **A dozen Surveyors**—The first return from the *Surveyor* work will be an answer as to whether man can safely land, exist and travel on the lunar surface. There will be experiments to gauge the radiation hazards on the Moon, and experiments to test the lunar soil to see how it will sustain bearing and traction loads.

Surveyor will also have instruments seeking out the thermal properties of the lunar surface and subsurface, their chemical composition and magnetic properties. A seismograph system will measure the gross properties of the lunar mass.

Plans call for building seven *Surveyor-A* flight vehicles, at a total R&D cost of from $180 million to $200 million; and five *Surveyor-B* flight vehicles, at a cost of $132 million. The latter amount includes, in addition to development costs, the money needed for launch vehicles, salaries and institutional support.

Hughes Aircraft Co., *Surveyor* prime contractor, will integrate the instruments into final spacecraft package.

Electrical power will be furnished by a radioisotope device developed by the Martin Co. Known as *SNAP 11*, the power package will weigh about 30 pounds, including shielding to protect the instruments, and will provide a minimum of 18.6 watts continuously for 90-day lunar missions.

Subsystem developers holding study contracts on *Surveyor* or letters of intent: Texaco Experiment Inc., coordination and development of surface and subsurface geophysical probes; Defense Systems Div. General Motors Corp., soil mechanics experiments; Lamont Laboratories of Columbia University, seismographic system; Norelco of North American Philips Co., X-ray spectrometer and X-ray diffractometer; Beckman Instruments Inc., gas chromatograph.

• **Many jobs for TV**—The four television cameras on *Surveyor* will watch the lunar terrain, monitor some of the scientific instruments, and perform several experiments of their own.

As the spacecraft approaches the Moon, the cameras will begin taking pictures of the impact area. These photos will be of a wide area; it is hoped that they will include familiar lunar features. The first frame is to cover 200 x 200 kilometers, with a resolution of about ⅓ kilometer.

As impact becomes imminent, the cameras will take pictures of smaller scope—300 meters x 300 meters, with a resolution of about ½ meter. The entire series of pictures will include identifying overlaps, so that a mosaic can be made.

After the spacecraft lands, the television system will continue its surveillance of the lunar surface. The system will have three picture capabilities—wide angle, narrow angle, and high resolution. When a camera is focused on a subject four meters away, the capabilities will have a resolution of 4 millimeters, 1.0 millimeter and 0.2 millimeters, respectively.

Furthermore, the wide-angle and narrow-angle modes will be able to survey the complete azimuth and also cover the area from 20 degrees below the lunar horizon to 45 degrees above The high-resolution mode is not expected to have the same wide azimuth scope; it will be designed to "see" from about 15 degrees below the horizon to 45 degrees above—a region necessarily within that of the coarser systems.

The size and shape of objects near the spacecraft is to be derived from a stereoscopic capability of the television system; two cameras will be selectively used, one taking wide-angle shots and the other narrow-angle shots of the same scenes.

Beyond its map-making contribution, the television system will also be counted on to make three scientific measurements—photometric, colorimetric and polarimetric.

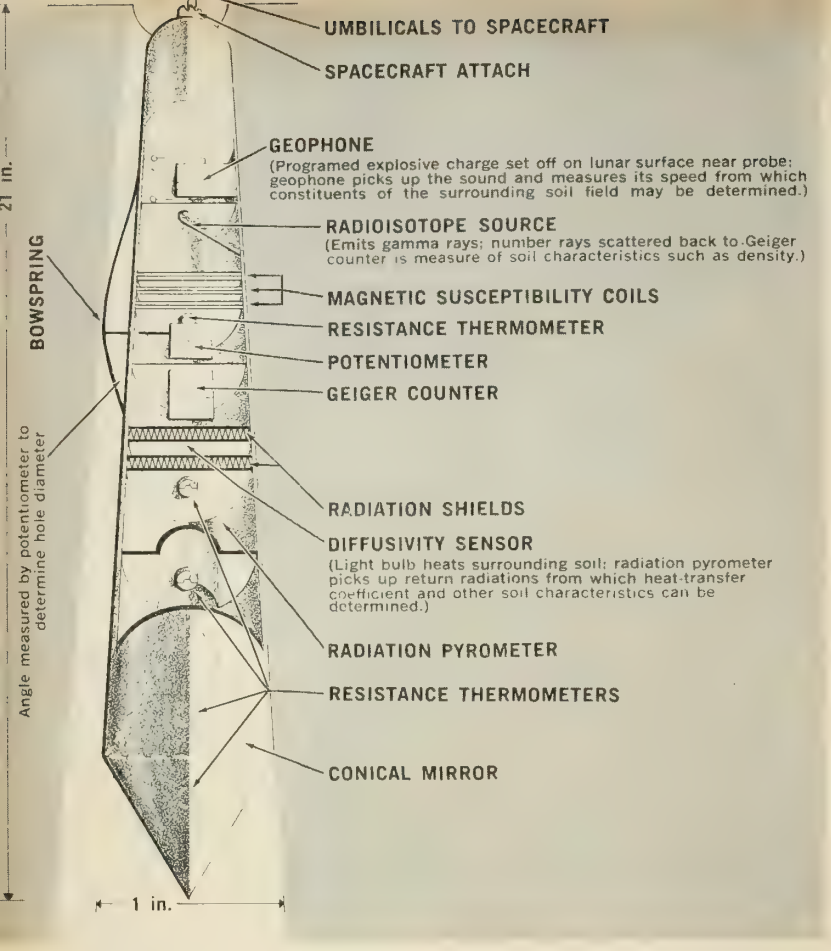
For its photometric work, the system is to be able to distinguish at least eight levels of grey. Colorimetric measurements are to be made through the use of three color filters. For the polarimetric measurements, an analyzer consisting of a single polarizing filter will be used.

• **Studying the Moon's surface**—Two banks of geophysical instruments are to be used, one to get data about the lunar surface and the other about the subsurface. The two banks are functionally related because they both seek to observe the same physical phenomena.

Properties of the lunar surface to be measured:

—Temperature.
—Thermal diffusivity and conductivity.
—Density.
—Magnetic susceptibility.
—Acoustic velocity.
—Penetration hardness.
—Soil mechanics.

Temperature. Measurements of the radiation temperatures of the lunar sur-



GEOPHYSICAL subsurface probe makes measurements every half-foot as it moves down five-foot hole.

face are to be made at selected times during the lunar day and night, and also at lunar sunrise and sunset.

The area chosen for these measurements—as for all scientific observations—is to be within picture-taking view of the spacecraft's television cameras.

To get a wider view of the terrain, the temperature-measuring instrument is to be located about four feet above the lunar surface; measurements are to be made at five-degree increments in the angle ranging from the lunar horizon to 45 degrees below it. The measurements are to be accurate to within 1°K over the expected range of 120°K to 400°K.

Thermal diffusivity and conductivity. The thermal properties of lunar material are to be found by "eclipsing" a 10-in.-dia. circular area of the lunar surface by a suspended disc, then measuring the temperatures beneath it during the lunar day and night.

Daytime measurements are to be made at about local lunar noon: the solar shield is moved over the area under study and measurements are made of the surface temperatures at the center of the shaded area as a function of time.

During the lunar night several sets of measurements leading to knowledge of the thermal lag are to be made: the solar shield is emplaced; heat is supplied to the lunar surface from a heater in the shield; and the surface temperatures are measured as a function of time during and after the heating period.

The first nighttime set of measurements is to be made just before sunset, the second at local lunar midnight, and the last just before sunrise. (If only one nighttime set of measurements can be made, specifications say they shall be made just before lunar dawn).

Expected range of thermal conductivity is 5×10^{-7} to 1×10^{-2} cal/cm sec°C; and expected range of thermal diffusivity is 1×10^{-6} to 2×10^{-2} cm²/sec.

The temperature-monitoring instrument is to be able to measure temperatures within 1°K when they are changing as rapidly as 3°K/min.

Density. A density measurement is to be made of a small *in-situ* volume of material, bounded on its under side by the lunar surface. The density figure is required to be reasonably accurate over the range from 0.4 to 8.0 gm/cm³; within 0.1 gm/cm³ in the range below 2.0 gm/cm³; and within five percent in the range from 2.0 to 4.0 gm/cm³.

Magnetic susceptibility. The magnetic susceptibility of material at several lunar locations is to be obtained by a measuring system placed on the lunar surface after a null calibration of the system has been made above the surface and away from the spacecraft. Television views of the surfaces under observation will permit compensation for local irregularities near and below the instrument.

Design range of measurements is to be from 8×10^{-5} to 0.1 in cgs. units.

Acoustic velocity. The speed of sound through lunar material is to be measured by means of two acoustic receivers plus a sound source acoustically decoupled from the spacecraft. Acoustic range of the system is to be between 300 fps and 25,000 fps.

Penetration hardness. Resisitivity of the surface will be determined by observing the wave form measured by an accelerometer mounted on a weight dropped from a short distance onto the Moon. Two of the weights will have conical tips so they can penetrate rock, and a third weight will have a hemispherical nose in the event the weight drops onto dust.

The derived wave forms will be compared with standard wave forms obtained on Earth, and the resistivity will be identified as equivalent to that shown by the appropriate Earth material.

Soil mechanics. Surface locomotion on the Moon requires a fairly good estimate of the surface's ability to take loads and to support traction. The load-bearing ability will be found by means of two separate axially loaded plates whose sinkage rates into the lunar surface will be measured as a function of applied load.

Shear strength of the lunar material will be found by means of a shear-ring test. A torque is applied to a spudded annular ring which successively undergoes different constant axial loads. The shear torque is then found as a function of axial load and angular displacement of the ring, and from these data the cohesion coefficient and friction angle of the lunar soil are derived.

• **Studying the subsurface**—Measuring the same physical quantities as the surface probe, the lunar subsurface probe will be lowered half-foot by half-foot into a small-diameter, five-foot-deep hole previously drilled by another spacecraft instrument.

At each half-foot step along its way, the probe is to make physical observations by means of devices indicated in

MACH 3

MAGNETOHYDRODYNAMICS

TURBOJET

LIQUID HYDROGEN

ROCKETS

DIVERSITY... at PRATT & WHITNEY AIRCRAFT

CRYOGENICS

HYPERSONIC PROPULSION

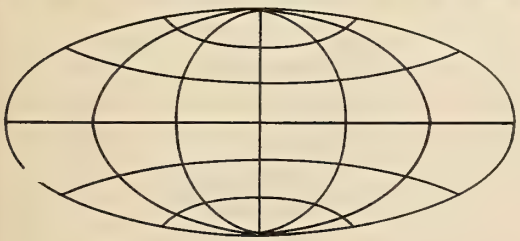
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the probe diagram shown in this article.

The sound velocity through lunar soil is to be measured between a point on the lunar surface about two feet away from the hole and the probe's various stopping points.

The hole diameter, expected to be about two inches, will be measured as a function of the deflection of a bow-spring. This spring also will stabilize the subsurface probe by forcing it flush against one side of the hole.

Other observations: density, magnetic susceptibility, thermal diffusivity and temperature.

• **Sounding the lunar mass** — A seismic and gravimetric experiment will give data on the gross physical properties and inertial structure of the Moon.

Equipment carried up for the experiment will include a leveling system, short-period vertical seismometer, three-component long-period seismometer; and feedback control circuitry.

As soon as a lowering mechanism within the *Surveyor* spacecraft puts this equipment on the lunar surface, the servosystem for leveling the seismometers will begin operating—leveling the instruments to within ten seconds of arc of the lunar vertical.

The short-period vertical seismometer is to provide an output of 50 millivolts per millimicron of ground displacement.

The three-component long-period seismometers will be tuned to provide 25 millivolts per millimicron of ground displacement. One component will measure vertical displacement while the other two measure two mutually perpendicular components of ground motion. Gravity tide and tilt data will be obtained by monitoring the feedback signal required for maintaining central alignment of the long-period seismometers.

Calibration of all outputs will be made on command.

• **Chemical analyses** — Three instruments will be used to determine the elements, minerals and compounds that make up the lunar surface.

X-ray spectrometer. A soil-transport system will put a prepared sample of lunar rock beneath the viewing port of an X-ray spectrometer. The sample will be bombarded by an electron beam—much like a target in an X-ray tube. Finally, the X-ray emission of the sample will be scanned to find out what chemical elements are in the material.

This lunar X-ray spectrometer is to have 13 dispersive channels, each designed to detect a particular element, plus one additional to note background noise and a second for calibration.

The X-ray spectrometer is to have the ability to scan no less than 20 successive samples and to detect within them the following elements and to

Project Surveyor Funding

(in million of dollars)

	FY 1961	FY 1962	FY 1963 (est.)
Project Management & Support		0.363	0.965
Systems Analysis & Integration	0.715	0.209	0.480
Structural Design & Development	0.035	0.158	0.225
Spacecraft Development Contract	4.871	23.150	29.100
Orbiter Spacecraft Development Contract		7.050	18.050
Planning & Documentation Support	0.076	0.136	0.275
Data Reduction & Processing		1.849	8.450
Scientific Experiments	0.759	6.840	10.110
Environmental Requirements & Testing		0.049	0.350
Scientific Experiment Analysis	0.454	0.329	0.570
Communications & Telemetry	0.088	0.124	0.150
Guidance & Control	0.056	0.206	0.280
Alternate Mission Package	.....		5.100
Orbiter Surveillance Subsystem	... ..		5.478
Computer Support	.....	0.037	0.495
	7.054	40.500	80.078
Centaur Launch Vehicles		0.537	17.300
Total, Surveyor	7.054	41.037	97.378

some extent their relative abundance: aluminum, calcium, chlorine, chromium, iron, magnesium, manganese, nickel, potassium, silicon, sodium, sulfur, and titanium.

X-ray diffractometer. A mineralogical analysis of lunar specimens will be made by an X-ray diffractometer. The instrument is expected to identify the minerals present, and determine their relative quantities and precise composition.

Gas chromatograph. The miniaturized lunar gas-chromatograph—about one-tenth the size of a standard laboratory model—is to separate and identify gases and organic compounds obtained from the lunar surface and subsurface. The instrument will weigh about 12 pounds and will be about 10 inches high and eight inches wide and deep.

• **Lunar fields and particles**—Four instruments will be used to measure the lunar atmosphere, fields and particle impingements: magnetometer, plasma probe, lunar-atmosphere gauge, and radiation detectors.

Magnetometer. A spacecraft-borne vector magnetometer will be used to measure the magnitude and direction of the lunar magnetic field and also the variations in it caused by interactions with any interplanetary plasma or fields.

Plasma probe. A spacecraft-borne plasma probe will be used to measure the energy spectra of low-energy charged particles (solar plasma) as a function of arrival time and direction. The information gained will help in interpreting the data from the magnetometer.

The plasma probe will consist of a box with five particle entry ports in its upper surface. A charged particle entering one of the ports traverses an electrostatic field between concentric plates which terminate at a Faraday collector.

For a given potential difference between these concentric plates, all charged particles having a certain energy per unit charge and angle of incidence will reach the collector. This potential difference is varied in time (12 discrete steps) to allow the determination of the particle energy spectrum.

A thirteenth step provides electrometer calibration. One of the five detectors analyzes particles incident from the vertical direction, while the other four point at 45° to the vertical and are equally spaced about it.

Lunar atmosphere gauge. The experiment package will contain a sensor gauge, magnet, pressure seal, electrometer, and high-voltage supply.

Gas atoms or molecules will be ionized by impacts with electrons inside the sensor. The magnet serves to contain the electron field inside the sensor in order to increase the collision frequency.

The positively charged particles will be collected and the subsequent current monitored by an electrometer. The output of the electrometer is calibrated against known standards on Earth, and thus the experiment can be used to measure absolute pressure.

The gauge is to be capable of measuring pressures in the range of 10^{-7} to 10^{-14} mm Hg.

Radiation detectors. The instruments are to measure the flux of charged particles with energies above a certain threshold, and the ionization produced by the same flux. The ratio of these data will be proportional to the average specific ionization of the detected particles.

The instruments will be arranged to detect protons having energies greater than 10 Mev, alpha particles having energies greater than 40 Mev, and by direct penetration electrons with energies greater than ½ Mev. Electrons with less energy will be detected through the bremsstrahlung process. ❖



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Asset Re Entry Research Spacecraft.
Mercury Carrying first Americans into space.
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LET'S SWAP RESUMES

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Technical Countdown

ELECTRONICS

Coast Survey to Use Satellites

Establishing the true distance across the U.S. within 10 meters will be the first project in a program of satellite-aided measurements to be started by the Coast and Geodetic Survey early in 1963. Other measurements of the Earth will follow. The new system of triangulation is based on the optical tracking of *Echo*-type satellites with modified Wild BC-4 ballistic cameras. The satellites will be tracked against a background of stars whose identities and positions are accurately known. Earth positions can be derived from this data.

AC Spark's Metrology Lab Operational

A precision geodetic laboratory is providing AC Spark Plug production engineers with extremely accurate azimuth references for the testing of missile guidance components and systems. Three special target collimators are housed in the new facility on isolated concrete pads. Azimuth information is obtained through "star" sighting, and one collimater beams the data directly into the plant to align the secondary collimators. The complex method is necessary because precision gyros must be aligned in azimuth with respect to true north for performance testing.

Digital Seismograph To Be Developed

Texas Instruments will perfect a direct digital Earth vibration sensor under an Air Force contract for Project *Vela Uniform*. The digital seismograph could provide data on underground nuclear explosions in a form readily used with high-speed computers. It would avoid the time-consuming translation procedures associated with present seismographs. The $167,000 contract was awarded by the Electronic Systems Division and will be monitored by the AF Cambridge Research Labs.

Russians Chide U.S. Scientists

American scientists were cited for their failure to exploit published Soviet space literature in an *Izvestiya* article by K. Gringauz. The Russian specifically mentioned the inaccurate Soviet estimate of the flux of electrons in the center of the second radiation belt. This was later corrected in the Journal of the Academy of Sciences, but the initial erroneous estimate was quoted in American articles for almost a year after this. "It was only recently," notes Gringauz, "that Iowa researchers came to the same conclusion after analyzing the data from *Explorer XII*." (M/R, January 29, 1962, p. 31)

Celestial Research Center Formed

A new center for celestial mechanics research will be established at Yale University under Air Force sponsorship on July 1. Dr. Dirk Brouwer, director of the Yale Observatory, will head the center; the staff will consist of 8 to 10 teaching and student fellows. The work will deal primarily with the effects of gravitational forces in determining the orbital paths of celestial bodies and space vehicle trajectories.

ADVANCED MATERIALS

X-15 'Q' Ball Adapted for Saturn

The spherical "hot nose" air data sensor developed by Northrop Corp. for the *X-15* research rocket plane is being specially adapted for the *Saturn C-1* booster. Initial use will be for high-altitude wind investigations, but subsequent *Saturns* will use the "Q" ball to supply instrumentation outputs for telemetry and possibly for ascent control of the vehicle. The *Saturn* device configuration will include fixed sensing ports.

High-Pressure Window Perfected

The first direct-visual observation of phase transitions and other changes occurring in substances at extremely high pressures has been achieved at the National Bureau of Standards Crystallography Lab. The window used by researchers consists of a diamond about $\frac{1}{16}$ in. across. The materials under observation are squeezed between flattened diamond faces at pressures exceeding 1 million psi. The processes are seen with a microscope through one of the diamonds. The high-pressure transitions shed light on interatomic forces and the perturbing effects of neighboring atoms on one another.

PROPULSION

Aerojet to Fire 100-in. Solid

Aerojet will fire a 100-in., 700,000-lb.-thrust segmented solid motor at its Sacramento facility June 9. A simulated *Titan II* engine will be mounted near the nozzle of the huge solid to check out the *Titan III* environment. The five-segment, 175-ton motor has a mass ratio better than 90, say Aerojet spokesmen, and the computed cost of the engine, based on the re-used case, is $2.40/lb. If the motor case were new, the cost would jump to $2.72/lb. Liquid thrust vector control using nitrogen will be a part of the test, one of six remaining under an Air Force contract.

Marquardt Tests New Attitude Rocket

A 12-oz. ablative chamber designed for a 26-lb. thrust attitude control rocket was successfully tested by Marquardt Corp. The chamber reached an I_{sp} in excess of 300 sec. The duty cycle tests were conducted in an altitude chamber at 0.02 psia, simulating three flight missions. More than 500 pulses were recorded over a total firing period of 8 minutes.

Conical Segments Vetoed in 120-inch Solid

The Air Force turned thumbs down on conical segments in the *Titan III*, 120-in. solid boosters. The shaped segments have been pushed by United Technology Corp., prime on the big solid booster. The Air Force wants a cylindrical configuration to take advantage of interchangeability—something not feasible with tapered sections. UTC still backs the conical concept for larger boosters because of its growth potential.

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there's a ship on the way to the moon

There will be many interim steps; but every shot on the Atlantic Missile Range puts the U. S. closer to its goal of a lunar landing in this decade.

Soon our capabilities on the range will be sharply increased as Mobile Atlantic Range Stations—large transports being converted to seagoing laboratories under Sperry system management—go into service.

Sponsored by the Missile Test Center of Air Force Systems Command, these MARS ships will incorporate every advanced technique of data acquisition and handling, integrated instrumentation radar, telemetry, inertial navigation, weather forecasting. Able to go anywhere in thousands of miles of ocean, they will provide for refined study of space vehicles during the critical terminal phase of flight.

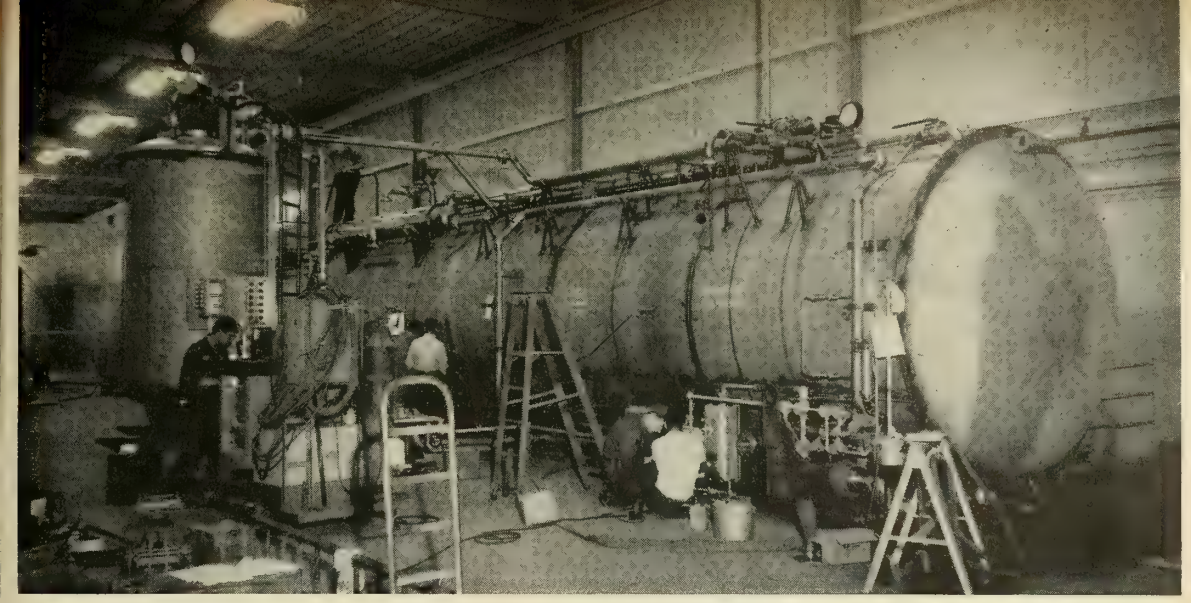
The MARS ships will help fulfill AMR's responsibility with NASA for range instrumentation supporting our exploration of space. And the capabilities developed will be steadily advanced in pace with the program. Team members with Sperry include Bethlehem Shipbuilding, Ford Instrument, Gibbs & Cox, IT&T and Remington Rand UNIVAC.

SPERRY



MARS SYSTEM MANAGEMENT GROUP, *SPERRY GYROSCOPE CO., DIVISION OF SPERRY RAND CORP., GREAT NECK, N. Y.*

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CHECK-OUT of main and vernier tanks. Final assembly took place in polyethylene-lined clean bay in background.

advanced structures

Titan II Fuel Tanks Open New Vistas

A RELATIVELY SMALL metalworking firm which won a *Titan II* subcontract was startled at first by the stringent requirements. But it soon found the job an illuminating exercise in uncovering new manufacturing potentials.

The *Titan* project, providing three propellant storage and conditioning systems, "was similar to making a fine precision watch in the middle of a blacksmith shop," says John G. Hagan, president of Hagan Industries, Inc., "but the experience has shown us that Space Age requirements in sophisticated metal fabrication have opened up an advanced technological area demanding new skills and a willingness to experiment in uncharted areas."

"Companies willing to meet the exacting demands of these missile requirements," Hagan observed, "are upgrading their own capabilities and making a substantial contribution to the defense effort."

The Martin Co. gave City Tank Corp., a division of Hagan Industries, the job of building the tank complexes, designed to stabilize the *Titan II* storable propellant temperatures at the optimum efficiency level and then pump them into the missile at a rate up to 200 gallons a minute.

The contract has opened new business areas for City Tank—since the requirements are similar, at least one field could be solid-rocket motor cases.

• **Rigid specs**—Prior to the Martin contract, the firm had supplied jet and missile containers, but City Tank production experts were astounded by the almost unheard-of fabrication and assembly techniques required by the propellant tanks.

Each propellant storage and conditioning system consists of two 20,000-gal. stainless steel tanks, fabricated from 304L stainless. There are two 1000-gal. vernier tanks and various operating parts.

Extremely rigorous quality control standards were imposed. All welding, welders and welding materials were governed by ASME codes and Air Force specifications. Every square inch of the huge tanks and all the welds required complete X-rays. Over 2700 feet of X-ray film was shot and developed for quality checks.

A total of 75 welders were pretrained for the project, the majority were recruited locally. Of this group, only 54 were finally assigned to the *Titan II* tanks, and each man measured up to the ASME and AF requirements.

The welding and metalworking techniques involved in 304L stainless were new to City Tank. Chipping hammers of 304L had to be used to descale the welds, 304L welding rods were required and minute records of all batches of the low carbon stainless used in the project had to be kept.

Records were maintained for strict compatibility of metals, welding rods, and scaling of welded seams.

A log covering each vessel detailed every inch of weld and welded surfaces and contained the names of the welder and the inspector.

Since the *Titan II* must carry an exact volume of fuel for guidance purposes, the measurement system in the fueling tanks had to be painstakingly calibrated down to fractions of gallons.

The position of the tanks for each of the three systems was noted exactly at the firm's Culpeper, Va., location in order to precisely duplicate the set-up at both Denver and the Cape. This meant a complete stress analysis—rarely required for common tanks—at a cost of $6500. This data alone filled 27 pages in the exhaustive log compiled for each system.

By far the most difficult consideration in the tank assembly was the cleanliness standard—the insides of the tanks and certain components could not tolerate a speck of dirt larger that one six-hundredth the diameter of a human hair.

Clean room procedures exceeding LOX specifications were carried out in a polyethylene "room". Immediately after initial fabrication, the system was completely dismantled and re-assembled in the pressurized area.

City Tank discovered one most irritating aspect of cleaning procedures—a 72-cent gasket cost $6.00 to clean. ⌘

Saturn G&C Parts Get Quick Check-out

Ten-week program aimed at giving NASA a quick clue to reliability of semiconductors

WAYNE, N. J.—A fast-moving component test program is being conducted here by Associated Testing Laboratories, Inc., to check out random samples of 33 different diodes and transistors which will be aboard at least the next four *Saturn* booster test flights.

The components, supplied by 13 manufacturers, are used in the huge booster's guidance and control system.

The current round of testing at Associated got under way early in April; by the middle of this month, the lab hopes to supply NASA's Huntsville, Ala., space flight center with the first significant data on the reliability of these components.

This portion of the testing is being done on somewhat of a crash basis, since NASA officials are pushing for the reliability information before the next *Saturn* launching—No. 3 in the series—tentatively set for October.

Though the first two flights of the rocket were considered highly successful, the space agency is making a serious effort to limit the chances of an inexpensive transistor causing an abort in the multimillion-dollar *Saturn*. According to Associated vice president for R&D Daniel Schochet, "we are indulging in some fairly prosaic testing to save a very exotic vehicle."

The Associated program is aimed at providing meaningful data for *Saturn* engineers at Huntsville about ten weeks after the start of testing. Schochet points out that the program was designed, requirements outlined, and actual testing begun two weeks from the receipt of the first batch of components.

• **Test parameters**—The test program is divided between measurement of basic performance parameters and a series of operating and storage environmental checks.

The performance parameters checked include leakage currents, saturation voltages, gain at dc levels and also in the VHF (200 megacycles) range, output capacities, switching time characteristics at speeds to 1 nanosecond, noise figures, and some small signal parameter tests at 1 kc.

The thermal portion of the environmental series includes temperature cycling between −65°C and +200°C, moisture-resistance tests at humidity levels approaching 100%, thermal shock tests to check glass-to-metal seals, and case leakage checks using both hydrostatic (gross) and helium (fine) techniques.

Shock tests of the devices are being made to 1500 g's for a 1-millisecond duration; radial accelerations up to 20,000 g's along each axis are provided to stress internal connections; vibration extremes run to 50 g's at 2000 cps. Altitude tests were conducted at chamber pressures of 10^{-5} in. of mercury.

Following the performance parameter and environmental series, the components are being subjected to a two-phase (operational and high-temperature storage) 2000-hour life test. Schochet reports that significant indications during these life tests are generally available after about 500 hours, since most semiconductor components, if they are going to fail, generally do so in the first 100 hours. For this reason, frequent checks are made during the first 100 hours, with the inspection intervals lengthening considerably after that point.

The ten week schedule which Associated is aiming for in effect includes reaching this 500 hour mark. The tests will continue through the full 2000 hour period, however they hope to have a realistic appraisal of component behavior before this.

• **Some shock problems**—Thus far, with the components now in an early phase of the life tests, Schochet reports there have been no really significant trouble spots, though there are some "problematical" areas observed during shock tests of certain components.

The current Associated program, which Schochet estimates will cost somewhat less than the original $28,000 figure, covers components which are only likely to be used in the next four *Saturn* flights. By flight No. 7, NASA reportedly hopes to use more advanced devices which will call for a different test regime. A follow-on contract for this effort is said to be under negotiation with the space agency. Costs for this second award could run between $25,000 and $45,000.



He assembles space vehicles for launching... in orbit

This AMF engineer's problem is to evaluate methods of accomplishing rendezvous missions: how to find, retrieve, dock (align, index, mate) space-vehicle components in orbit. Dozens of methods were investigated. The model shown is already outmoded by superior concepts and designs. This work is being performed under contract for application to current and future space programs.

AMF investigation capabilities encompass mechanical and human requirements from earth to moon and beyond:

From launching—to assembly and operations in space—to the total spectrum of requirements for man's survival and operations on the moon. AMF has investigations under way, including work on equipment such as:

Lunar traversing vehicles.
Temporary, semi-permanent and permanent lunar bases.
The mechanics of survival in the hostile environment of radical temperature changes, vacuum, and radiation.
Absorption of landing shock on the moon's surface.
Life-support systems.
Aero-space and medical equipment.

Many of these studies cover problems common to *any* mission to the moon regardless of its ultimate objectives.

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MARS Ships May Aid Decoy, A-ICBM

Data collected at sea could lead to improved decoys and discrimination radars; AF reported buying third vessel



NEW RADAR ANTENNA for MARS missile tracking ships is hoisted atop a test tower on Sperry Gyroscope Co.'s new mile-long radar range at Manorville, N.Y. The 30-ft. dish is part of Sperry's Integrated Instrumentation Radar (IIR), the largest precision radar yet developed for shipboard use.

NEW YORK—The stationing of two Mobile Atlantic Range Station (MARS) tracking ships downrange from Cape Canaveral late this year or early in 1963 may provide U.S. defense planners with vital information on detection and sorting of real ICBM's from missile decoys.

The Integrated Instrumentation Radar (IIR) to be carried aboard these ships will, it is reported, not only provide downrange data on missile trajectories and nose cone re-entry phenomena, but be configured to collect data on the missile decoy detection problem.

The radar requirement to seek out the legitimate warhead from a host of decoys has long been a limiting factor in the development of a truly effective long-range A-ICBM system.

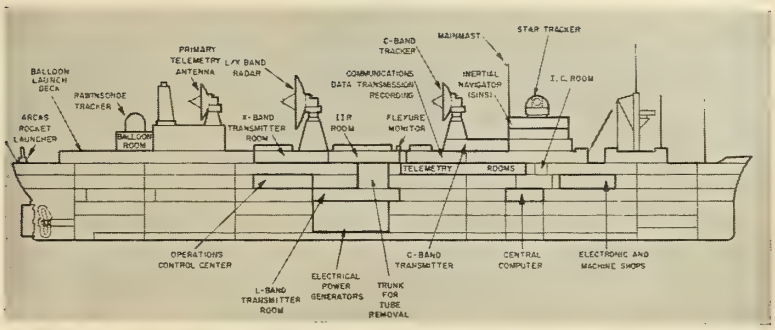
For offensive planners, data of this type could be of great value in developing more refined decoys for U.S. missiles.

The IIR, developed by the Sperry-Rand Corp., prime contractors to the Air Force on MARS, will actually combine a C-band, L-band, and X-band radar into one integrated tracking and data-gathering system employing two antennas rather than three. The C-band tracking radar will operate solo from a 30-ft. dish located forward, and the L- and X-band systems will be operated in phase from a single 40-ft. installation located amidships.

The decoy sorting role reportedly will be played by the L- and X-band system. The L-band portion of this system will utilize the entire antenna area, with the X-band function requiring only the center portion. Both the major tracking and data collecting radars can operate synchronously or independently.

rograms

by Michael Getler



DRAWING shows complex equipment aboard a Mobile Atlantic Range Station.

• **Ten-ship plan**—First details of the MARS program (M/R, May 19, p. 34) indicated that 10 ships would eventually make up the mobile tracking fleet, with the first six vessels classified as master ships acting primarily in support of the ICBM, A-ICBM, and penetration aid programs, and ships 7 through 10 named satellite or support vessels.

The existing two-ship program which Sperry manages with support from several of its own divisions, plus ITT Federal Laboratories, Gibbs and Cos, Inc., Marine Architects and the Bethlehem Steel Co., is worth about $70 million. A request for quotes on the third ship has also reportedly gone out from the AF.

It should be noted that the MARS program and the ARIS (Advanced Range Instrumentation Ships) program are one and the same. The confusion reportedly developed when the name was switched in mid-stream, but most persons continued to call the program by its original name—MARS. According to Sperry, MARS has once more been sanctioned, at least for these first two vessels.

Positioning of these first two ships will most likely be along the final leg of the 5000-mile water gap which separates the Ascension Island tracking post and the nose cone impact areas in the Southwest Indian Ocean. This will, in effect, provide almost complete coverage for the expanded 10,000-mile Atlantic Missile Range, with new and sophisticated instrumentation added in the final re-entry and impact areas where accurate data collection is vital.

• **Assignments**—A breakdown of instrumentation system capabilities for the MARS vessel released here this week includes:

—Missile system evaluation.
—Terminal phase trajectory measurement.
—Splash point determination.
—Nose cone re-entry phenomena.
—Evaluation of penetration aids.
—Nose cone recovery operation.
—Mid-course phase trajectory measurements.
—Manned spacecraft monitoring.
—Ship-launched ballistic missile evaluation.
—Lunar probe monitoring.
—Meteorology measurements.

The IIR described by Sperry engineers can reportedly acquire both range and angle data on a primary and two secondary targets simultaneously in real time. This system is said to be complete with centralized control consoles, automatic fault indicators, redundant assemblies, error monitors, trainers, and built-in-test equipment.

The 1½-ton C-band tracking radar, currently undergoing tests at Sperry Gyroscope Co., is actually an outgrowth of the AN/SPG-56 guidance radar developed by the firm for the Navy's *Talos* surface-to-air system. The radar is made of aluminum and is said to be virtually free of distortion across the reflecting surface even under shipboard conditions.

LOS stabilization for the tracker is provided by gyros mounted at the 30-ft. antenna pedestal. The tracking data is corrected for ship's motion through a hook-up with the MK 1 SINS (Ship Inertial Navigation System) and a MK 19 gyro compass carried aboard the MARS vessels. A flexure monitoring system also contributes to continuous alignment data by measuring any actual flexing of the ship's frame while at sea.

• **Fixing position**—A star tracker reportedly capable of sighting on sixth-magnitude stars at night and third-magnitude stars during the day is housed atop the ship's bridge and is used to up-date the inertial system. A sonar bottom transponder beacon is also used as an aid to establish position. The three systems can reportedly fix actual ship's position to within a few yards.

The second 30-ft. dish aboard the ship, located aft, will handle the telemetry chores and can also be used for detection of beacon-equipped recoverable nose cones. Eight T/M channels are provided capable of handling data from some 700,000 data points, far in excess of the usual number of telemetered missile functions.

Each ship's meteorological capabilities will include standard weather data instruments, beacon-equipped radiosonde balloons for measurements to 100,000 ft. and *Arcas* sounding rocket launching facilities to check conditions to 250,000 ft.

Ship's time will come from a system at Canaveral synchronized with the U.S. Bureau of Standards. Receipt of the signals is expected to be within an accuracy of 10 milliseconds, with a holding accuracy within the crystal-controlled time system of 5 parts in 10 billion.

All tracking and target data and ship's position information will be recorded primarily in digital form. The data-processing center for the instrumentation system is a shipboard modification of the Univac 1206, a low-power unit similar to the one being installed at the Ascension Island station. ⌗

(Continued from page 17)

was removed from the *Ranger IV* and *MA-6 Atlases* because of leakage, was not removed from Carpenter's booster. Air Force officials said there had been extensive checks of the insulation and all gave it a clean bill of health. However, all future *Atlas-D* space boosters are slated to have the insulation removed.)

• **Spacecraft changes** — Several modifications in the *MA-7* spacecraft were carried out as a result of Glenn's flight in February. Warning-signal circuitry for the heat shield was wired in series and rigged further away from the actuation points to prevent accidental operation. This was the core of the problem which caused uncertainty about the status of Glenn's heat shield just prior to re-entry.



CARPENTER is helped out of his flight suit shortly after arrival on Intrepid.

(M/R asked Project *Mercury's* Manager, Kenneth Kleinknecht, if future astronauts would be informed about such potentially fatal situations while they were in space. There was strong feeling on the part of John Glenn that he should have been informed about the uncertain status of his heat shield. Kleinknecht said such decisions will be made on the spot by the responsible official in the control center.)

In the attitude-control system, which caused Glenn some problems, steps were taken to make *Aurora-7's* thrusters more clog-resistant and to improve the thermal characteristics of the chambers. Changes included replacement of the stainless steel wire mesh with platinum wire, repositioning of the fuel-metering orifice, smaller internal chamber volume, and a new fuel distribution plate.

Addition of a "glove compartment" to the instrument panel allowed Carpenter to stow small items such as film cassettes, filters, and other items designed for use during carrying out of his experimental functions.

• **Experiments** — Several specific scientific experiments were set up for Carpenter, which he had difficulty carrying out as his technical difficulties arose.

A balloon experiment intended to determine the visibility of various colors in space was partially successful, although it was only partly inflated. The 30-in.-dia. balloon attained a diameter Carpenter estimated at ten inches, due to improper inflation.

The five colors covering the balloon's surface were examined by Carpenter for ease of visibility, and Day-Glo Orange seemed most visible, with aluminum next, he reported. Direct application of the information is anticipated for rendezvous orbital missions such as *Gemini* and *Apollo*. Motion of the balloon in the wake of the *Aurora-7* was described as completely random, and it did not fall behind as quickly as expected.

The mylar-aluminum sphere was painted Day-Glo orange, aluminum, white, yellow and phosphorescent. A small metal beam, instrumented with a strain gage, measured drag on the balloon. The tethered sphere was released from the antenna section of the spacecraft at the beginning of the second orbit. Unable to cut it loose at the end of its usefulness, Carpenter ignored it and the experiment burned up in the atmosphere upon re-entry, with the exception of a portion of the nylon tether, which inexpliciably survived the re-entry.

A second experiment to determine the behavior of liquids under extended periods of weightlessness was carried out, and was one which required no action on Carpenter's part. A small glass flask, three inches in diameter, was half-filled with green-dyed water containing an aerosol solution to reduce surface tension, then mounted on the bulkhead over Carpenter's shoulder.

The camera which observed Carpenter during flight could also watch the flask. About 300 milliliters of the distilled water contents had a choice of forming globules, uniformly distributing around the sides of the spherical flask, or any other reaction. A perforated standpipe in the center of the sphere, and extending to its center, allowed the liquid to flow freely about. A silicone additive was included to inhibit foaming.

A flare experiment, designed to supply some data on attenuation of light by the earth's atmosphere, did not come off as planned due to cloud cover over Australia, where the flares were to be ignited. Each one million candlepower, the flares were to be observed by Carpenter through filters.

New foods, more Earthlike than those tested by Glenn, were tried by Carpenter during his flight, and proved not very satisfactory. They were crumby. The bite-size snacks included solid food cubes with a special space coating over cereals, compressed date nut bars, and chocolate.

Three photographic experiments were carried out during the flight; daylight color, photography of any subject of scientific interest, using special haze filters; a test requested by the weather bureau to determine particular wavelengths on photographs; and an MIT-requested study of the Earth's horizon to assist in design of the *Apollo* guidance system, with the objective of determining the definability of the horizon.

• **Recovery forces**—Reflecting what may be either increased confidence on the part of NASA or decreased availability of Navy ships, the recovery force for *MA-7* contained only one aircraft carrier, compared with three for the Glenn flight. The carrier USS Intrepid was at the end of orbit number three, but Marine helicopters slated to pick up Carpenter at the end of orbits one and two were deployed aboard floating drydocks instead of carriers.

The usual contingent of destroyers, tankers and long-range patrol planes were on hand, but the absence of the carriers was noteworthy. The floating drydock ships (LSD) were prepared for their mission by loading them with one ton of extra medical supplies and equipment.

• **Solar flare prediction** — After a period in which NASA did not obtain solar-flare-predicting services from the

(Continued on page 39)

Industry Trends and Reviews

Sperry Gyroscope Co. engineers voted 1669 to 1069 against union representation in a National Labor Relation Board election. Technical non-professionals also voted no to representation by the International Union of Electrical Workers. Company president Dr. Carl A. Frische said of the results: "We are pleased that our engineering and technical staff has finally had an opportunity to express its opinion in a free election. We are gratified that the professional employees have chosen to work directly with the company toward achieving our engineering objectives without intervention of a third party. We now can look forward to more mutually beneficial employee relations." . . . *Western Electric's North Carolina Works is being transferred from the Defense Activities Div. to the telephone-making Manufacturing Division. The shift, said a company spokesman, is because ". . . uncertainties concerning the future of our Nike-Zeus work have posed problems for us. Although I have the greatest faith in the Zeus system . . . the decision to go ahead with production of this system lies properly with others. No one can guess what this decision will be or when it will be made."* . . . The Air Force Office of Scientific Research awarded more than $1.7 million in basic research grants and contracts to 25 universities and six research firms in the U.S. . . . *California has the greatest concentration of scientists and engineers in the country, reported the Los Angeles Chamber of Commerce. A total of 22,788 work in areas related in one way or another with the defense industries. The only close competitor is New York, with 21,659.* . . . The Martin Co. placed orders for almost $45 million worth of materials, supplies and services during the first quarter of 1962 with firms in areas of substantial unemployment. The company placed almost a third of its procurement dollars with small business—some $32.5 million during the first quarter.

New Names in The Industry

U.S. Scientific Devices was formed in Los Angeles to specialize in ultrahigh resolution and fiberglass optic cathode-ray tubes for video recording, radar oscilloscopes, monoscopes, character generators, flying spot scanners and monitors. . . . *Thermotron Corp. was formed in Holland, Mich., to design, manufacture and market thermoelectric cooling and heating systems for environmental test chambers and commercial refrigeration. President is Charles F. Conrad.* . . . Lee Orpin Associates was organized in La Jolla, Calif., as a marketing consultant in the electronic-aerospace field. The firm will specialize in evaluation of long-range market potential for new technical developments. . . . *Solid State Specialists, Inc. was formed in Mt. View, Calif., as a distributor of electronic components following purchase of Finn Electronics, San Carlos, Calif. The group will specialize in solid-state items such as micro circuits, planar transistors, diodes, tantalum and aluminum capacitors, resistors and pots.* . . . Jamieson Industries, Inc. has been set up in Van Nuys, Calif. It will be "high-geared for an elaborate program of design/development and manufacturing, marketing and world distribution, of a broad range of trade-named products in the Electronics, Missile/Space, Industrial/Commercial and Consumer fields." . . . *Temtech, Inc. is the new name for Temtre, Inc., Santa Ana, Calif., designers and manufacturers of ultra-precision temperature sensors and control subsystems for industry and military.* . . . Computer Products, Inc., was formed in Manasquan, N.J., to specialize in analog computer modernization, display systems, and electronic mode controls. . . . *Hermetic Industries is the new name for Hermetic Seal Corp., Rosemead, Calif. President Mannes N. Glickman said the new name reflects the company's recent diversification into other lines of electronic components, "and its plans to diversify further through the acquisition of other companies."*

New Industry Facilities

Republic Aviation Corp. will invest over $1.5 million in an advanced physics research facility to be incorporated into the company's Paul Moore Research and Development Center. The facility, scheduled for operation next spring, is needed to handle company work in plasma propulsion and other areas of magnetohydrodynamics research, said company president Mundy I. Peale. . . . *Crescent Engineering & Research Co. of Los Angeles opened a plant in Philadelphia to supply engineering, manufacturing and marketing facilities for transducers, electronic instrumentation and control systems.* . . . Fairchild Camera and Instrument Corp. opened a West Coast Facility in Palo Alto, Calif. The Defense Products Div.-Palo Alto will design and produce a variety of advanced aerospace and ground systems. . . . *Raytheon Co. plans to add a 100,000-sq.-ft. building to its Bedford, Mass., engineering and development laboratories to help relieve overcrowded facilities as well as provide room for the Missile and Space Div.'s expanding engineering programs.* . . . Bell Aerosystems Co. established a Tuscon (Ariz.) Research Laboratory to conduct R&D activities leading to state-of-the-art improvement in electronic and electromagnetic concepts, systems, and analysis.

News of Mergers and Acquisitions

Air Products and Chemicals, Inc., Allentown, Pa., acquired Keenan Welding Supplies Co., Albany, Georgia. . . . *Lear, Inc. stockholders approved the merger of Lear and The Siegler Corp. Siegler stockholder vote is pending. If approved, the merger is expected during the first part of June. The new corporation will be known as Lear-Siegler, Inc., with headquarters in Los Angeles.*

High flow at 5,000 PSI...

pneumatic solenoid valve for aero-space vehicles

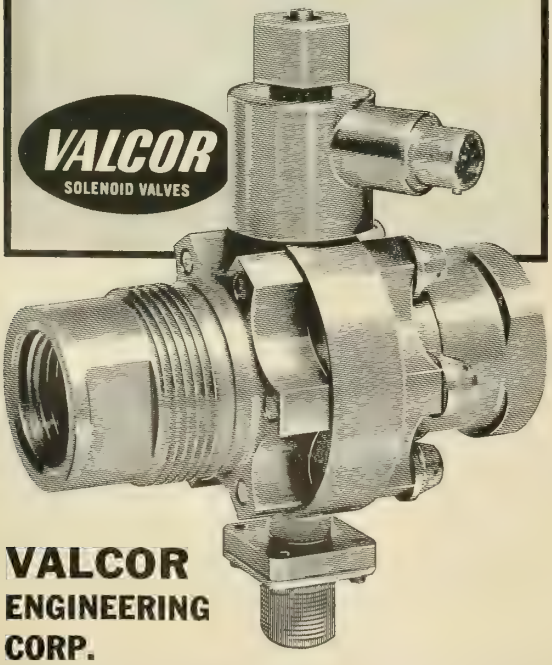
THE new Valcor solenoid valve, Series 387, was developed and is currently being qualified especially for the aero-space industry's new super rockets, where high operating pressures, combined with extreme temperature variables, must be controlled ... **exactly!**

A major aspect of this valve design is its flow characteristic: the Series 387 has, we believe, **the lowest pressure drop of any poppet valve!** Designed for fuel, hydraulic and pneumatic applications, its co-axial feature allows a high rate of flow at 5,000 psi, at temperatures ranging from —65°F to +500°F.

Series 387 is considerably smaller than comparable valves capable of equal flows at 5,000 psi. Smaller size and co-axial design drastically simplify its installation.

The unusual bulkhead mount design allows the valve to function through vibration up to 20G and shock loads up to 40G. And its unique valve seat design enables the unit to withstand the erosive effects encountered in high pressure, high flow pneumatic systems.

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contracts

AIR FORCE

$8,842,769—**General Cable Corp.**, Rome, N.Y., for production of inter-site cable for *Minuteman* installations in the vicinity of Minot AFB, N.D. Work to be done at Bonham, Tex.

$3,819,538—**Lockheed Missiles and Space Co.**, Sunnyvale, Calif., for component improvement of *Agena* space vehicles.

$3,710,599—**Space Technology Laboratories, Inc.**, Los Angeles, for systems engineering and technical direction for *Atlas, Titan* and *Minuteman missiles*. Work to be done at Redondo Beach, Calif (supplemental contract).

$3,455,025—**Sperry Gyroscope Co.**, Great Neck, L.I., N.Y., for instrumentation of C-4 ships for use on the Atlantic Missile Range (supplemental contract).

$3,349,000—**Douglas Aircraft Co., Inc.**, Santa Monica, Calif., for work on the *Skybolt* weapon system (supplemental contract).

$2,902,663—**General Dynamics Corp.**, San Diego, Calif., for provision of installed property and related equipment for installation and checkout of *Atlas* missiles.

$2,800,000—**Lockheed Missile and Space Co.**, Sunnyvale, Calif., for research and development for space satellite systems.

$2,100,000—**American Air Filter Co.**, Rock Island, Ill., for production of *Minuteman* environmental control systems. Work to be done at St. Louis (supplemental contract).

$1,824,376—**Boeing Co.**, Seattle, for depot tooling for *Minuteman* missile assembly and disassembly.

$1,790,854—**American Bosch Arma Corp.**, Hempstead, N.Y., for depot-level maintenance in support of the *Atlas* missile (supplemental contract). Work to be done at Garden City, N.Y.

$1,493,953—**Hughes Aircraft Co.**, Culver City, Calif., for work on the *Falcon* missile weapon system (supplemental contract). Work to be done at Tucson.

$1,363,271—**Martin Marietta Corp.**, Baltimore, for provision of spares and related equipment for the *Titan I* weapon system (supplemental contract). Work to be done at Denver.

$1,310,000—**Aerojet-General Corp.**, Sacramento, Calif., for production of *Minuteman* solid-propellant rocket motors and related equipment.

$1,050,000—**Aerojet-General Corp.**, Azusa, Calif., for fabrication and delivery of *Titan II* propulsion units (supplemental contract). Work to be done at Sacramento.

$1,000,000—**North American Aviation, Inc.**, Downey, Calif., for production of *Minuteman* guidance and control systems (supplemental contract).

$1,000,000—**General Electric Co.**, New York City, for production and test of airborne guidance equipment for space vehicles (supplemental contract). Work to be done at Syracuse.

$1,000,000—**Lockheed Aircraft Corp.**, Burbank, Calif., for work on space vehicles (supplemental contract).

$1,000,000—**Pan American World Airways, Guided Missile Range Div.**, Patrick AFB, Fla., for management, operation and maintenance of the rocket research facility at Fort Churchill, Manitoba, Canada.

$500,000—**North American Aviation, Inc., Autonetics Div.**, Downey, Calif., for study of design advances for an improved *Minuteman* intercontinental ballistic missile.

$225,000—**Martin Marietta Corp.**, Baltimore, for study of systems requirements for electronic command and control equipment for use in directing limited war forces.

ARMY

$5,823,000—**Collins Radio Co.**, Dallas, for building and installing communication equipment in portable communication terminals for *Pershing* missiles (supplemental contract).

$1,052,868—**Instruments for Industry, Inc.**, Hicksville, N.Y., for classified work.

$99,000—**Martin Marietta Corp.**, Orlando, for three dynamic demonstrators and training aids for the *Birdie* air defense coordination system.

NAVY

$4,455,500—**Bendix Corp.**, Mishawaka, Ind., for continued research and development on the *Typhon* missile system.

$3,282,904—**General Electric Co.**, Pittsfield, Mass., for guidance units for *Polaris* missiles.

$1,925,000—**Bendix Corp.**, Mishawaka, Ind., for engineering services on *Talos* missiles.

$1,125,000—**Republic Aviation Corp.**, Farmingdale, L.I., N.Y., for design and fabrication of a ship's control training device for the FBM-616 Lafayette *Polaris* missile submarine.

NASA

General Electric, Phoenix, Ariz., for four 225 computers which will perform scientific and engineering data analysis on the design of the *Saturn* booster vehicle (undisclosed amount).

INDUSTRY

$600,000—**Superior Manufacturing & Instrument Co.**, New York City, from **Radio Receptor Co., Inc.** and **Westinghouse Air Arm Div.**, for servomechanisms.

$570,000—**Schaevitz Engineering**, Pennsauken, N.J., from **General Dynamics Corp.**, for accelerometers for use in the *Tartar* and *Terrier* missile programs.

Mercury-Atlas 7

(Continued from page 36)

Air Force's Sacramento Peak Observatory (New Mexico) before its manned shots, such predictions are now being utilized.

Sac Peak points out that May 5, the day on which Alan B. Shepard made his suborbital flight, their prediction was "unsafe", but apparently no one asked their opinion until the Glenn flight, when a "safe" period was forecast.

(The Soviets, on the other hand, flew Major Titov during the only three safe days in April, 1961, and had had a similar window during which Yuri Gagarin was launched.)

Coordination between NASA and Air Force on the solar flare problem has now been set up, and a safe forecast by Sac Peak was a prerequisite for scheduling the Glenn flight. Several times daily, for a period of approximately two weeks before each shot, forecasts are telephoned to the radio warning stations of the National Bureau of Standards at Fort Belvoir, Va. ⌗

Cape Nike Shots

Series to Gain High-altitude Data

CAPE CANAVERAL—NASA has scheduled a series of eighty *Nike* launchings at Cape Canaveral in an effort to obtain high-altitude wind data to aid in designing space boosters.

The single-stage vehicle will use the 50,000-lb.-thrust *Nike* solid rocket to push a chemical-filled nose cone to 70,000-ft. altitude. The nose cone, a 103-in.-long container, will dispense the FS smoke chemical in a long trail beginning at 2000 ft.

Three ground-based IGOR cameras will photograph the smoke trail, and trigonometric data reduction will be used to determine characteristics of upper-atmosphere winds so that presently inadequate knowledge of wind shears and other phenomena may be bolstered.

Although many such experiments have been conducted at NASA's Wallops Island station, there is a need to plot Cape Canaveral's upper atmosphere profile as accurately as possible for future launches, and significant differences exist in various areas. NASA wanted capability to measure up to 100,000-ft. altitudes, but budget limitations forced the agency to settle for 70,000 ft. Each of the 80 sounding vehicles costs about $2600.

UNION CARBIDE EXPANDS Rocket Propulsion Activities



. . . at its new Technical Center near Charleston, West Virginia, in the pleasant Ohio-Kanawha Valley.

Union Carbide Chemicals Company, pioneer in chemicals and plastics, offers new opportunities for technical careers in solid rocket technology and high energy propellants. Two years of Company-funded research has led to the development of novel concepts and processes for the fabrication of solid rocket motors for military missiles and space vehicles. Thirty-six classes of novel metal hydride adducts form the basis for intensive development of stable high energy fuels for storable liquid rocket applications. Union Carbide Chemicals Company, Division of Union Carbide Corporation, is making a major technical effort in the rocket propulsion field and is now expanding its program with the added impetus of government contracts. Advancing these new concepts to practical fruition affords unparalleled opportunity for personal job satisfaction. Openings exist for qualified applicants in the following participating disciplines:

ORGANIC CHEMISTS: Synthesis of high energy fuels based on organo-metallic complexes; evaluation of high energy fuel additives to improve combustion characteristics of liquid jet and rocket propellants. (PhD, MS; 2-5 yrs. exp.)

POLYMER CHEMISTS: Development of new binder systems, elastomers, cross linking agents and encapsulation techniques. (PhD; 2-5 yrs. exp.)

PHYSICAL CHEMISTS: Development of physical and mechanical testing techniques to permit evaluation of experimental solid propellant grains in terms required for advanced stress analysis studies. (MS, BS; 2-5 yrs. exp.)

SOLID PROPELLANT CHEMISTS: Formulation of propellant system incorporating novel high energy ingredients and binders; interpretation of test results to guide synthesis program. (MS, BS; 3-8 yrs. exp.)

THERMODYNAMICIST MATHEMATICIAN: Calculation and analysis of energetics and systems performance parameters for hypothetical liquid and solid propellant systems. (PhD, MS; 2-5 yrs. exp.)

CHEMICAL ENGINEERS: Application of arc torch and plasma jet to chemical synthesis as well as for electric propulsion; design and operation of novel experimental facilities. (PhD, MS; 3-10 yrs. exp.)

PROCESS DEVELOPMENT ENGINEERS: Process development and engineering studies of novel solid propellants and rocket motor manufacturing techniques; translation of advanced design concepts into practical chemical, mechanical and plastic processing operations. (MS, BS; 3-8 yrs. exp.)

BALLISTIC TEST ENGINEERS: Burning rate studies; static test firing of rocket motors and propellant elements; data reduction and analysis; adaptation and design of test instrumentation. (MS, BS; 3-8 yrs. exp.)

For more information and arrangements for personal interviews about available assignments, write to Mr. J. R. Kernan, Union Carbide Chemicals Company, Technical Center, P. O. Box 8361, South Charleston, West Virginia. Qualified applicants will receive equal opportunity; U. S. citizenship is a requirement.

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SPACE & UPPER ATMOSPHERE RESEARCH

APL seeks mature physicists, mathematicians, astronomers and geodesists to conduct upper atmosphere and space research in connection with the Transit, TRAAC, and geodetic satellites. The positions require men with a Ph.D. or M.S. degree and considerable experience.

The assignments are broad and will include (a) analysis of orbits, (b) research in geodesy and the ionosphere using data from satellites, (c) development of satellite-borne experiments for research relevant to the satellite programs.

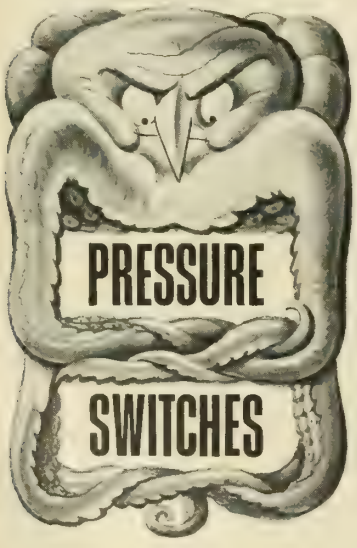
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Circle No. 14 on Subscriber Service Card

products and processes



New Product of the Week:

Coaxial Thermal Voltmeters

A LINE of coaxial thermal voltmeters—wide-range transfer devices for voltage measurement to 30 mc. or voltage comparison tests—is available from the Filmohm Corp. These voltage-indicating devices have high accuracy, flat frequency response and good short-time stability. Using a coaxial in-line configuration of a resistor and a UHF thermoelement, they are based on U.S. Navy Metrology Laboratory drawings from designs by the National Bureau of Standards. No periodic calibration is required nor lost in the event of thermocouple burn-out. Accuracies of 1 to 2% can be expected.

Rigid coaxial mounting positively maintains the mechanical position of both components and provides shielding between circuits. Rigid thermal gradients are isolated by the heavy, highly reflective case.

Circle No. 225 on Subscriber Service Card

High-Pressure Filters

A series of high-pressure T-type filters in either aluminum or stainless steel have been introduced by The Filter Division, Hydraulic Research and Manufacturing Co. These filters are designed for such typical applications as test stands, industrial hydraulic systems, ground flushing carts, propellant loading systems, fuel and oxydizer transfer systems, highly corrosive chemical process of ground based hot gas systems, and cryogenic systems.

Circle No. 226 on Subscriber Service Card

Thermoelectric Modules

Semitronics, Inc., announces development and production of miniature single and multijunction thermoelectric cooling modules. They are ideally suited for applications which require cooling of temperature-sensitive electronic components, such as transistors and memory cores, where spatial requirements are a major consideration.

Diameter is $\frac{9}{32}$ in. and height $\frac{11}{32}$ in. Temperature differential attained at 60°C is 25°C. Power requirements are 4.5 amps at .5 volts. Operating temperature range is from ±125°C to −100°C.

Circle No. 227 on Subscriber Service Card

Vacuum Gate Valve

An all-metal 4-in. gate valve developed for ultra-high vacuums by High Voltage Engineering Corp., is capable of repeatedly forming a vacuum tight seal equivalent to a welded or brazed joint. The unit (Series A-1142) provides positive closure for ultra-high-vacuum systems where chemically pure atmospheres are desired, as in semiconductor production, or where RF and electrical fields deteriorate organics as in high-power klystron tubes, and particle accelerators.

After more than 700 open-close

cycles, the valve has shown no leak or damage. The closed valve shows no leak as measured by a sensitive mass spectrometer leak detector, in either direction against an external pressure of one atmosphere of helium. The all-metal assembly withstands repeated bakeouts at 450°C.

Circle No. 228 on Subscriber Service Card

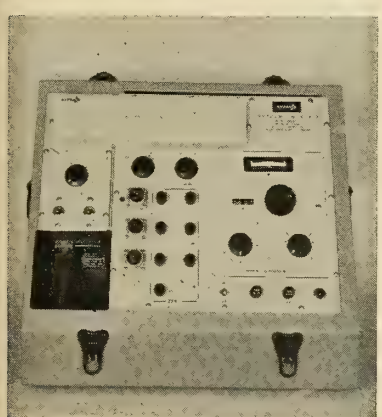
Cryo Shutoff Valves

A series of cryogenic shutoff valves is available from Accessory Products Co. Extended stem construction of the valves affords a higher maximum of safety in the handling of cryogenic fluids. Use of a positive stop mechanism provides additional safety by preventing stem blowouts due to service line explosions. For maximum temperature protection, Teflon packing is located above the liquid phase.

Circle No. 229 on Subscriber Service Card

Sensitivity Comparator

Bytrex Corp., has available the model CS-261 variable sensitivity comparator. This is a digital calibration standard having wide range and versatility. It has been designed for precision readout of any 4-arm strain gage



transducer, the calibration of pressure and load cells, and for use as a pressure or load standard with high quality transducers.

Circle No. 230 on Subscriber Service Card

Multiple Capacitor

Gulton Industries, Inc., has announced the availability of a multiple capacitor unit which is hermetically sealed with capacitance values of 1 mf-0.1 mf-0.01 mf and 0.001 mf within one single unit. The tolerance on these values within one unit is ±0.25%.

Use of the unit in oscilloscopes and other instruments can eliminate the need for employing potentiometers.

Circle No. 231 on Subscriber Service Card

AEROSPACE ENGINEERING PROJECT MANAGEMENT

Sustained growth in new and rapidly expanding weapon technologies at Hughes has created several openings for experienced design engineers with a demonstrated capability for mature decision-making in administration and supervision. These project management positions involve the supervision of 10-20 engineers and support personnel. They require an engineering or science degree from an accredited college or university, U.S. citizenship and a minimum of 5-10 years of directly applicable professional experience:

ENGINEERING SERVICES—Duties include personnel planning and recruitment, security, proposal cost coordination, department procurement functions, department space and facility planning and acquisition, budget, schedules and program monitoring.

STRUCTURES—Experience in the design of missile and/or aircraft type structures, components and their integration and supervision of groups assigned to design, advanced concepts, systems integration, electrical cabling and harness design.

LAUNCH CONTROL—Duties include general test planning, detailed test planning and procedures, range coordination, booster coordination, development of spacecraft GSE and all Hughes activities at Cape Canaveral.

STATION OPERATION—Will direct operations of Surveyor mission from Goldstone (Calif.) deep space tracking station, including installation and operation of command consoles, data processing and evaluation equipment.

PRODUCT ASSURANCE—To help set up and head an organization conducting inspection and quality control surveillance over advanced space system and weapon system projects in the research and development stages.

WEIGHTS—Ability to reorganize and manage a section oriented toward weight control rather than aircraft weight monitoring programs. Requires complete familiarity with current military specifications.

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MISSILE SYSTEMS ENGINEER

System engineering in Polaris Weapons System, including analysis of various complex electro-mechanical sub-systems. Will make comparisons of sub-subsystems operations, conduct necessary studies to confirm conformance of sub-system components with operational requirements, and engage in liaison with sub-contractors to support above activities. BSEE or equivalent. Experience in design of digital circuitry and related test equipment desirable.

SR. MATHEMATICIAN

Review and analysis of Polaris system functional design to determine a proper error assignment on a computational criteria basis. BS or MS in mathematics. Four to ten years' missile systems reliability experience desirable.

ELECTRICAL ENGINEER

Will analyze missile systems for good engineering practices to reduce radio frequency interference; conduct RFI measurements in lab and aboard ship to reduce specific RFI effects. Position requires experience in these areas or antenna studies, RF propagation theory, electromagnetic radiation hazard studies or associated design or evaluation. BSEE.

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MINASY



HUMPHREY



MALONEY



MUSSER

Dr. John P. Nash: Appointed a vice president of Lockheed Missiles & Space Co.

Nash has been director of the company's research activities since mid-1959, and in March of this year became director of research and engineering laboratories. In announcing his appointment, company president L. Eugene Root said the promotion "is a further recognition of the extremely important role of research and engineering at LMSC."

A. Waller Howard: Named marketing manager of General Electric's Large Jet Engine Dept., Evendale, Ohio.

Jeremy Taylor: Named executive assistant to the president of Belock Instrument Corp., College Point, N.Y. **Arthur J. Minasy** appointed vice president for operations in charge of production and engineering.

John B. Lawson: Appointed general manager of Ford Motor Co.'s Aeronutronic Division at Newport Beach, Calif.

Gustav A. Stachelhaus: Appointed manufacturing superintendent of the electronic defense laboratories of Sylvania Electric Products, Inc., Mountain View, Calif.

Josef K. Hoenig: Appointed director of European operations for Textron's Bell Aerospace Corp., Buffalo, N. Y.

Ralph E. Willison: Named manager-engineering and development of the new electronics division of Research-Cottrell, Inc., Bound Brook, N.J.

Dr. John L. Sprague: Elected senior vice president of the Sprague Electric Co., North Adams, Mass., and co-director of the firm's engineering laboratories.

George E. Spaulding, Jr.: Elected president of Consolidated Vacuum Corp., Rochester, N.Y .

Martin L. Lundquist: Named manager, quality control, for Western Scientific Instrument Co., Inc., Los Angeles.

Dr. Angelo Montani: Appointed assistant to the president of Ford Instrument Co., Long Island City, N.Y., a division of Sperry Rand Corp.

Richard T. Cowden: Named marketing manager, western states region, for the Space-General Corp., El Monte, Calif.

Gordon S. Humphrey: Appointed general manager of the Leach Controls Division of Leach Corp., Compton, Calif.

Dr. J. S. S. Kerr: Appointed manager of the radio guidance and tracking department in the guidance laboratories of Space Technology Laboratories, Inc., Redondo Beach, Calif.

Clement G. Maloney: Elected vice president for government operations of Kollsman Instrument Corp., New York City.

Carl F. Koch: Joined Rixon Electronics, Inc., Silver Spring, Md., as a senior engineer.

Russell E. Travis: Joined Vitro Electronics, Silver Spring, Md., as a senior mechanical engineer.

Dr. Stanley C. Grzeda: Joined the western operation of Sylvania Electronic Systems, Mountain View, Calif., as an engineering specialist in its reconnaissance systems laboratories.

Dr. Glenn L. Musser: Named president of HRB-Singer, Inc., State College, Pa. Former president **Dr. John L. McLucas** has accepted the position of deputy director of defense research and engineering, tactical warfare program, The Pentagon.

Henry Siegel: Secretary-treasurer of Computer Instruments Corp., Hempstead, N.Y., named chairman of the board.

Theodore E. Andrews: Appointed manager of engineering for Cryo-Therm, Inc., Fogelsville, Pa.

Michael R. Urban: Elected vice president in charge of sales and contracting for Del Electronics Corp., Mt. Vernon, N.Y.

Harold A. B. McInnes: Appointed vice president and director of operations for Dresser Electronics, SIE division, Houston.

G. Stuart Patterson, Jr.: Senior engineer in the advanced reactor systems section of the Martin Company's Nuclear Div., awarded a $5,000 company fellowship to continue studies leading to a doctorate at the Johns Hopkins University.

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—reviews—

SPACE RESEARCH II, Proceedings of the Second International Space Science Symposium (1961), Editors: H. C. van de Hulst, C. de Jager, and A. F. Moore, John Wiley & Sons, Inc. (Interscience Div.). New York, 1241 pp., $29.50.

In Florence, April 10-14, 1961, leaders in space science fields presented scientific papers to an invited audience limited to 250; this text is a collection of those papers. The meeting was jointly sponsored by COSPAR, the Committee on Space Research—the international body in which space scientists from East and West compare their plans and results and make arrangements for further cooperation—and the Consiglio Nazionale delle Ricerche.

The book covers the nine technical sessions: optical tracking and prediction service, radio tracking, dynamics of satellite motion, telemetry and data recovery, recent results from instrumented satellites and spacecraft, world magnetic surveys, special events, reference atmosphere, and research by means of sounding rockets.

Space scientists will find this thick volume a highly convenient source of data and analyses.

FUNDAMENTAL DATA OBTAINED FROM SHOCK-TUBE EXPERIMENTS, Edited by A. Ferri. Pergamon Press, New York. 415 pp., $12.

The volume presents a collection of 10 monographs in the fields of chemical, physical and thermodynamic problems investigated or investigable experimentally by shock tube techniques.

In the first three chapters, introductory information on unsteady flow motion and shock tube techniques is presented. The other chapters are examples of application, describing specific investigations in the fields of chemical physics and thermodynamics where shock tube techinques have been used.

DESIGN GUIDE TO ORBITAL FLIGHT, Jorgen Jensen, George Townsend, Jr., Jyri Kork and Donald Kraft, McGraw-Hill Book Co., New York, 896 pp., $17.50.

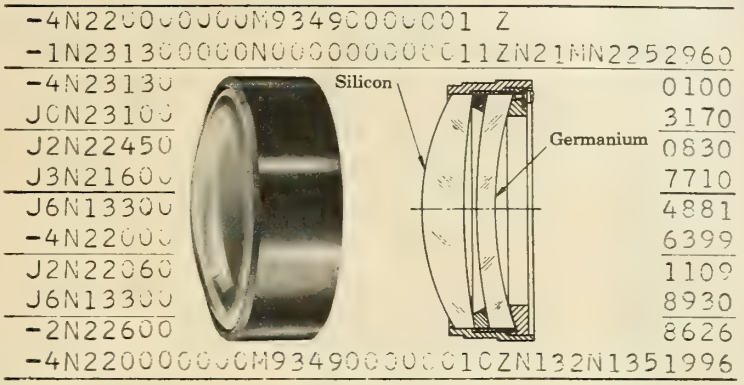
Four Martin Co. engineers have put together a creditable manual of design data applicable to orbital flight—including maneuvers, rendezvous, recovery and reentry. The information is said to have been derived from a literature search plus extensive work done by the Martin Co.

Verbiage is limited in favor of an abundance of design charts and pertinent mathematical treatments. The graphs, nomograms and tables are described as giving numerical values of various parameters within several percent.

Physical data included: iterative solutions of the transfer problems, minimum-energy orbital transfer, unconventional propulsion systems, ground-track predictions for satellites in eccentric orbits, unique formulation of the Keplerian ellipse, and effects of atmospheric rotation on satellite lifetimes.

This book will certainly be highly useful to engineers and scientists concerned with the design of space vehicles.

SERVO IR Report



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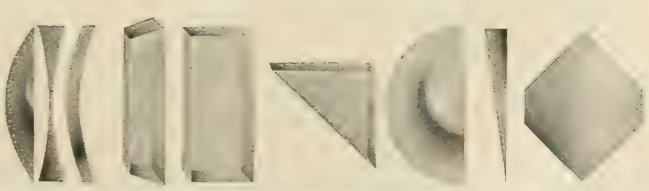
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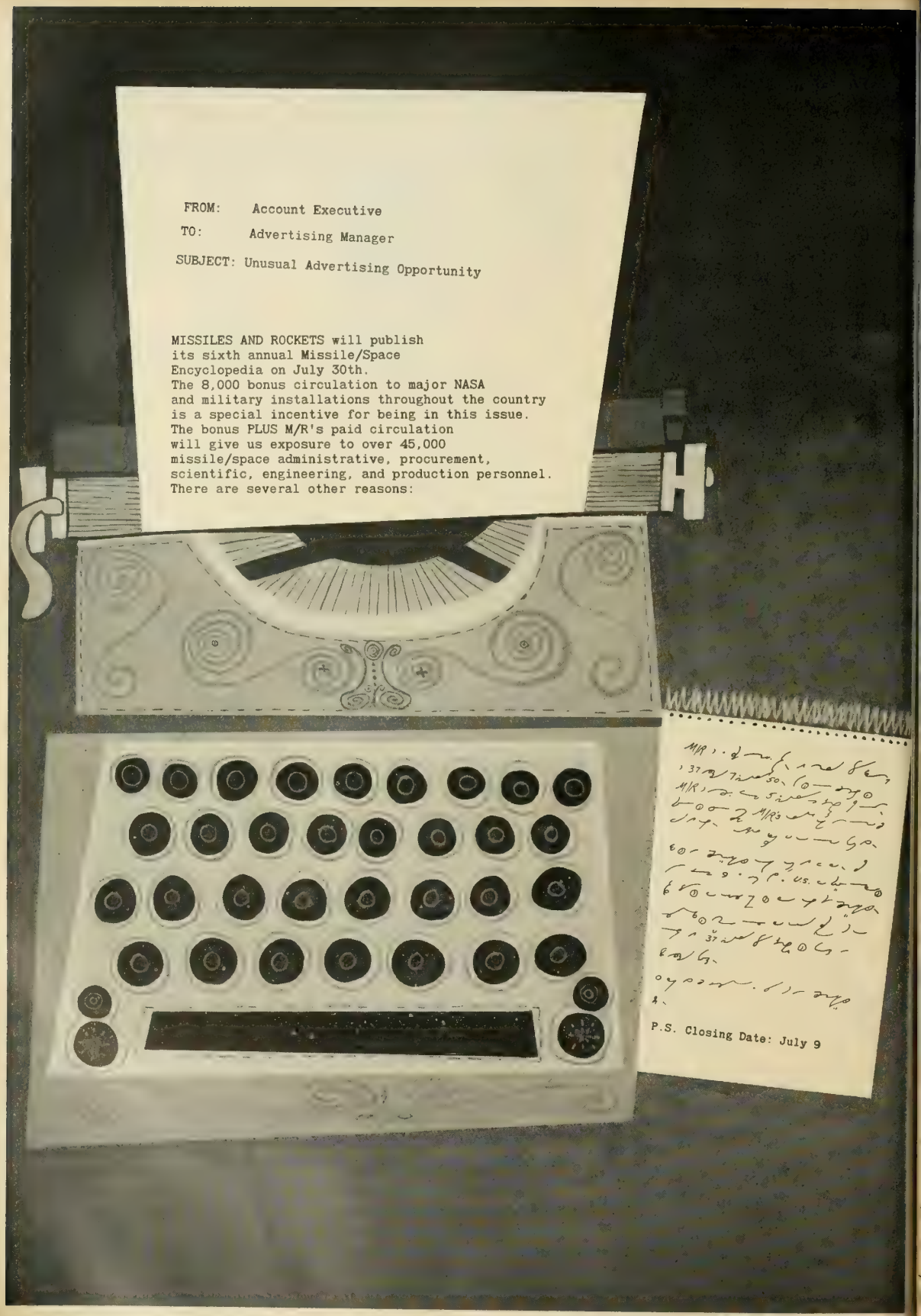
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Edison Electric Institute, Annual Convention, Atlantic City, N. J., June 4-6.

Engineers Joint Council, Nuclear Congress and Exhibit, The Coliseum, New York City, June 4-7.

Society of Technical Writers and Publishers, Annual Meeting, Sheraton Hotel, Philadelphia, June 6-8.

Society of Automotive Engineers, Inc., Summer Meeting, Chalfonte-Haddon Hall, Atlantic City, N. J., June 11-15.

Molecular Beams Conference, Brookhaven National Laboratory, Upton, N. Y., June 11-13.

Cornell University Seminars in Industrial Engineering Operations Research and Statistics, Ithaca, N. Y., June 12-15.

National Society of Professional Engineers, Annual Meeting, Sheraton-French Lick Hotel, French Lick, Ind., June 13-16.

American Institute of Electrical Engineers, Summer General Meeting and Aerospace Transportation Meeting, Denver Hilton Hotel, Denver, June 17-22.

American Nuclear Society, Annual Meeting, Statler Hilton Hotel, Boston, June 18-20.

Technical Writing Conference, University of Michigan, Ann Arbor, June 18-22.

Institute of the Aerospace Sciences, Annual Meeting, Los Angeles, June 19-22.

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Contracting and Public Trust

HEARINGS by the Senate Permanent Investigations Subcommittee into profit-pyramiding in the missile business are continuing to result in a very bad press for the industry.

There is not, unfortunately, much that can be done about this. The industry will just have to learn to live with it. The complex financial arrangements involved do not lend themselves to easy reporting and simplification almost inevitably leads to misunderstanding.

This misunderstanding is compounded by technical difficulties.

A headline writer cannot cram into two brief lines all the qualifications necessary for complete understanding. His headline therefore, while true, may be quite misleading—particularly when such terms as "100 percent profit" are involved.

The committee's attitude has much to do with what appears in the press. Selection of particular portions of particular contracts for attention can easily indicate conclusions that may be erroneous. The use of financial terms in an apples-and-oranges conjunction also can be confusing. It is incumbent upon committee members and staff to be as fair as possible in their statements.

On May 22, for example, Thomas E. Nunnally, General Accountant Office accountant on loan to the subcommittee, noted that Boeing Co.'s 1954 before-taxes profit on government business related to net investment was 100.1 percent. Subcommittee charts showed that before-taxes profit on government business in the eleven-year period 1950-61 was less than 10 percent when related to total sales. Boeing's after-taxes profit on *Bomarc* sales, discussed in this context, was only 3.6%, according to the testimony of R. W. Tharrington, assistant general manager of Boeing's Aerospace Division. This last figure compares to the 7.8% average of companies listed by Dow-Jones.

Confusing? Of course it is unless you carefully define exactly what you are discussing. That is why newspaper headlines on such stories often are misleading—these just isn't room for that type of definition. The industry therefore should worry less about the headlines and more about exactly what is going on in the hearing room.

There are some useful lessons to be learned there. Perhaps a major benefit of the hearings will be a warning to all who are so enthusiastically shouting of the benefits of incentive contracting that there are many pitfalls along that route.

Please do not mistake our intent. We heartily favor incentive contracting in the right places. Our philosophy long has been that the best way to get a man to do a good job is to give him an incentive for doing it. This applies to cost reduction just as surely as to quality.

But there are many problems to be solved in shifting to an all-out effort on incentive contracting. Industry spokesmen who warn of the dangers if incentive contracting becomes a "fad" in military and government procurement have these in mind.

The McClellan hearings turned, on May 24 and 25, into something of a trial of the merits of incentive contracting.

Chairman McClellan brought up a common question in regard to incentive contracting: are the savings real or do they result from initial inflation of cost estimates to provide a cushion for profit-taking? Even with considerable experience in cost estimating for incentive contracts, it always will be difficult to answer that question before a Congressional committee.

Much homework and a considerable amount of faith will be required of Congressmen looking into such contracts. Most companies in the industry would regard dependence on either as a prime hazard of doing business. This is one reason there is some industry doubt about this contracting approach.

Another suggestion by the committee was that the bulk of the "underrun" on the Boeing contracts discussed resulted from price reductions by subcontractors who were not on incentive contracts.

This overlooks Boeing's incentive stake in keeping its subcontract costs to a minimum. It also overlooks the efforts of every prime in the business to keep its subcontracting competitive, for quality as well as cost reasons.

ONE WOULD THINK from some of the comments at the hearing that the defense business was not a competitive business. Did you talk to anyone from Aerojet after UTC won the 120-inch solid booster contract? Did you talk to anyone at Martin after Lockheed won the *RIFT* contract? Then you know just how competitive this business can be.

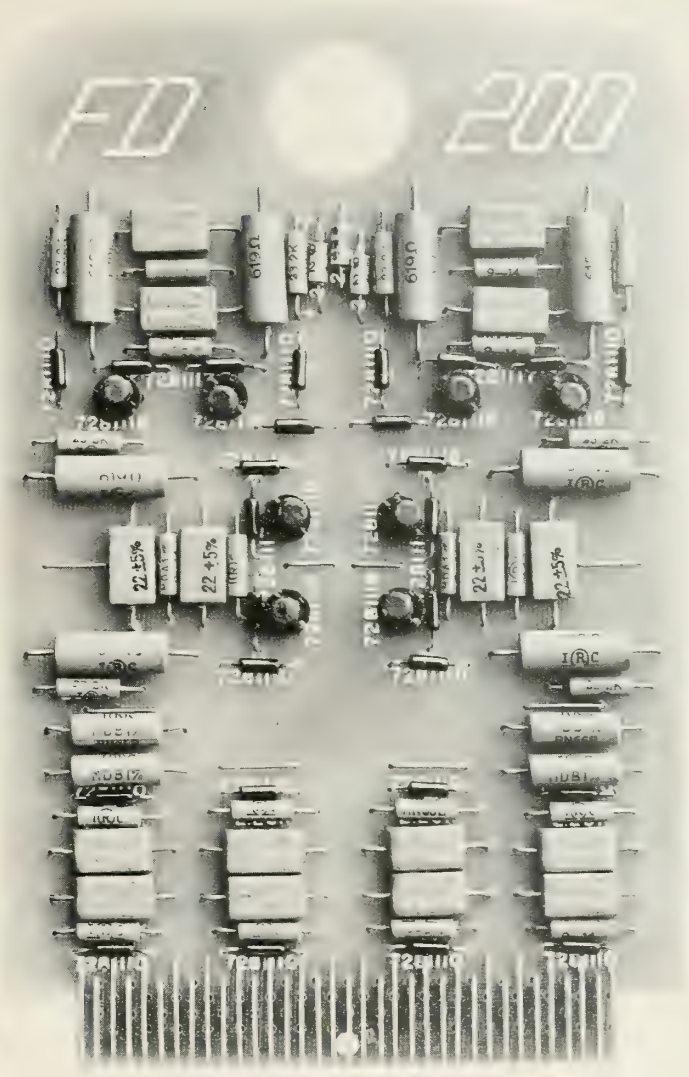
We were interested in this regard in the testimony of Maj. Gen. W. A. Davis, commander of the Air Force Aeronautical Systems Division. He said the Air Force currently is trying to work out means of separating inflated estimates from genuine efficiency in establishing incentive profits. He then added that his 17 years in procurement had convinced him that the CPFF (cost-plus-fixed-fee) contract is a less effective cost saver than the incentive contract.

That is just what it comes down to. Sooner or later, someone will have to demonstrate their faith in the 17—or 20 or 13—years of experience of the negotiators and estimators. Trust *has* to be placed in such men. That is why little will come of whatever conclusions the McClellan committee draws out of these hearings. The committee, quite rightfully, can bring the facts into view for comparison with other facts. But we doubt if it ever can come to a justifiable conclusion from those facts.

William J. Coughlin

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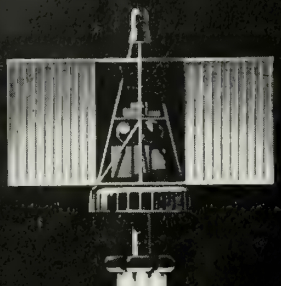
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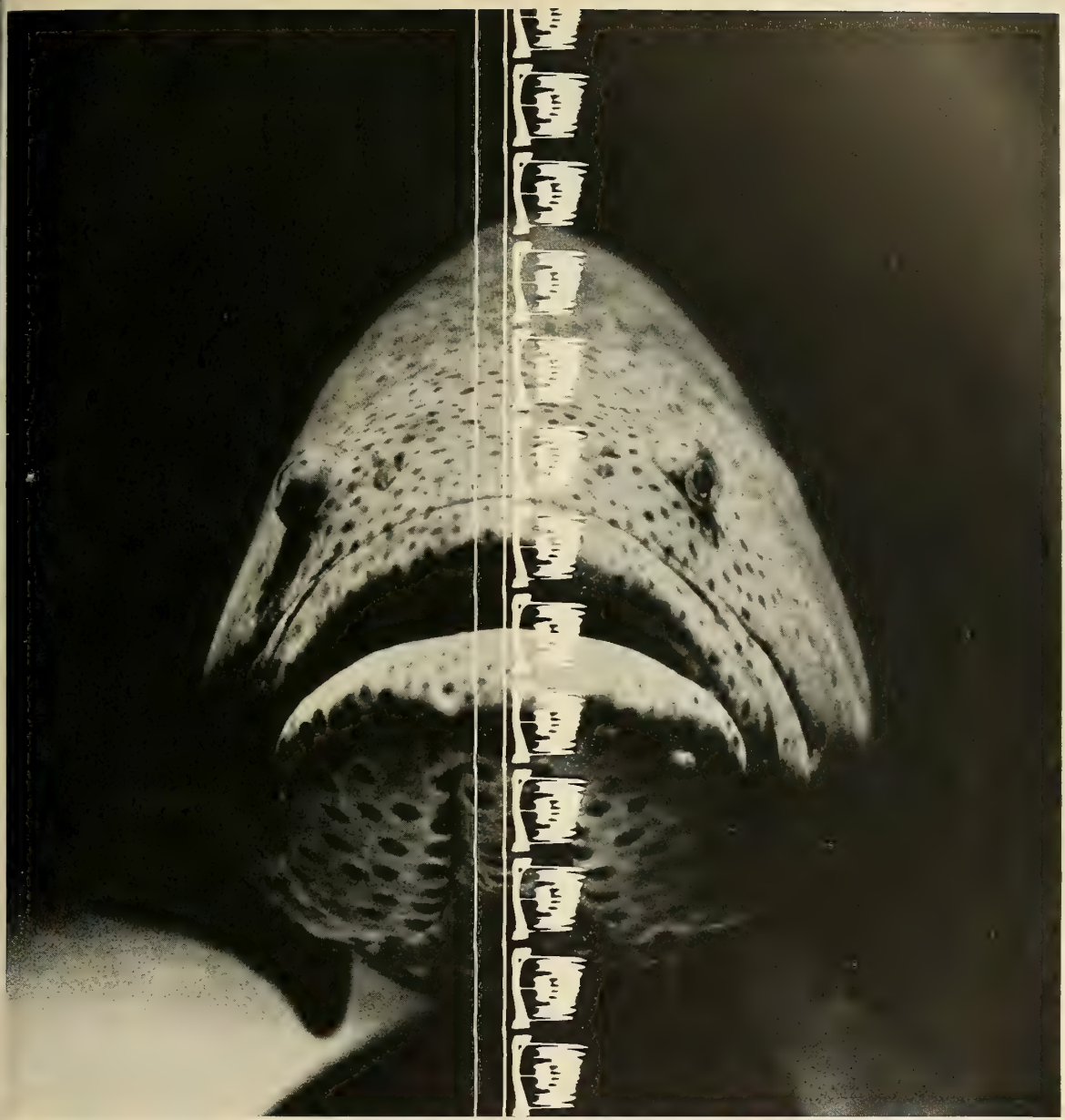
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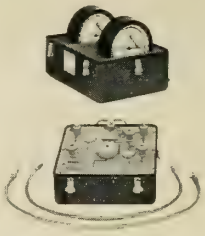
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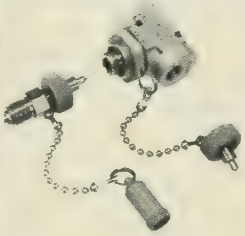
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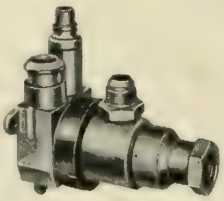
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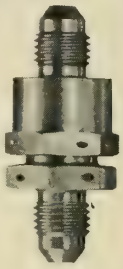
Pressure instrument calibration valves—Many models for calibration of various pressure readout instruments without removal from system or reduction of system pressure.



Manual control valves—Models for shut off and metering with finger tip control for pressure to 10,000 psi.



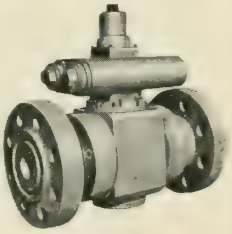
Pressure regulators—Many models available. Spring, hand, air and motor loaded. Single and multiple stage.



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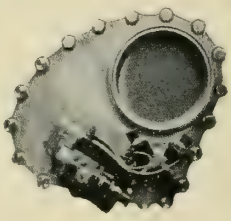
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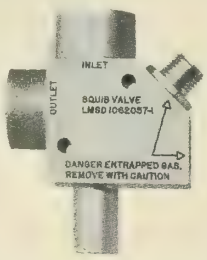
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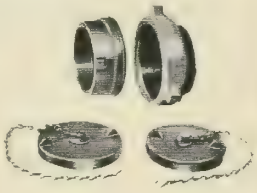
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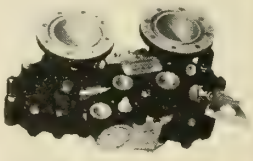
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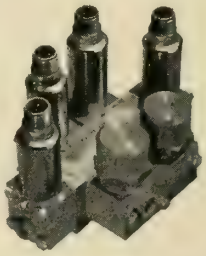
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missiles and rockets

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THE COVER

A giant step forward in the U.S. space effort was the first full-thrust, full-duration firing at Edwards AFB, Calif., May 26 of Rocketdyne's F-1 engine. The 1.5-million-lb.-thrust engine burned for 151.8 sec.

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letters

Wasteful Security

To the Editor:

Your editorials alone are ample reward and reason for subscribing to MISSILES AND ROCKETS. The one for May 7 ("Security—The Real Threat") was particularly timely. America can only accept the fact that the Pentagon is stupid, has always been stupid, and in all probability will continue to be stupid.

The thoughtful and responsible scientist hesitates to even discuss significant advances inside a security system that leaks like a sieve and is dominated by people who can barely understand their own thoughts, to say nothing of knowledge that is new to science.

Your policy does much to minimize the ill-effects and the increased cost in time and money that such a situation inevitably brings about.

Herman L. Moor
Chicago

GD's Lineup

To the Editor:

Your story on the NASA award of the *Little Joe II* booster indicates that the staff of your excellent magazine does not understand the General Dynamics Corporate Organization as it is operating today. The large Convair combine of years past has been divided into four separate autonomous divisions. Convair and Astronautics are separate divisions of GD, as are Fort Worth and Pomona.

The *Little Joe II* contract was awarded by NASA to General Dynamics/Convair, *not* GD/Astronautics. The bird will be designed and built at GD/Convair, *not* GD/Astronautics. Further, the name of the program manager is J. B. Hurt, not J. N. Hurt. Mr. J. H. Famme is president of GD/Convair. In general the technical concept as reported in your article is correct as we know it today.

Jack R. Burtt
Sr. Requirements Engineer-NASA
General Dynamics/Convair
San Diego, Calif.

Utilizing Engineers

To the Editor:

The continuing discussion of "engineer shortage" which appears throughout scientific and trade journal media eventually deteriorates into three general questions: Is there any shortage? Just who are we short of? What are we doing with the current supply?

Consideration of a few general "big picture" aspects is essential to produce order from chaos in any problem, and the technical talent shortage is no exception.

In round numbers, there are about 800,000 engineers, 70 million employed persons, and 180 million people in the United States. So we have better than one engineer per hundred workers and one engineer per three hundred population. Considering all the many things to be done in our society, I submit that we do have a reasonable supply of engineers. Ten years' employment experience in one civilian and three defense engineering positions has served only to substantiate this opinion.

There is no question that certain types of persons are not readily available. The men with ten solid years' experience in a discipline twelve years of age are few and far between. Fundamentally, nothing can or should be done to produce any large number of such people. Exceptionally intelligent persons with good judgment in any field are not and should not be in excess supply. Most defense engineering organization structures seemed designed for more chiefs than Indians, but this is far from the most efficient and sensible situation. Good engineers ought to be the exception and capable of contributions well above average. Converting everyone with x years' experience, y years of schooling, and z handbooks (all technical) into an engineer creates nothing but confusion.

Engineers frequently appear to believe they are capable of doing almost anything. Although this is perhaps an egotistical opinion, their actual activities do tend to reinforce such a belief. I am almost certain that somewhere in our society an engineer can be found in almost any activity you care to mention. Why aren't these people engineering?

Of course, there are many reasons. Fundamentally, society, industry and corporations have been unable to motivate engineers to do engineering work. Engineers are engaged in a spectrum of activities much too broad to justify any argument that they are in short supply. Items genuinely in short supply are sparingly used, command a high price, and have large supporting structures.

The three general questions can be answered simply: There is no shortage of engineers. *Experts* are in short supply. Not enough is being done to utilize the supply.

The general lines of what should be done are fairly clear. The only mystery is why engineers, business and society do not implement them.

A limited definition of an engineer should be established. State licensing is at least a beginning. A single organization should monitor both admission to the profession and activities of practicing members. It should be tough to become an engineer, and you should either produce or get out, to put the matter bluntly. Recognition should be made of the fact that a great many engineers are also employees. Working conditions are valid group-discussion questions, and if such discussion is illegal we should change the law . . .

Ralph E. Bower
Registered Professional Engineer,
New York State
Denver, Colo.

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DC Digital Voltmeter and Ratiometer (Model 507D). Measures voltages between ±100 microvolts and ±1000 volts, ratios between ±0.0001:1 and ±999.9:1 with 0.01% (of reading) ±1 digit accuracy. Accessories permit AC/DC and AC/AC ratio measurements. Stepping switches guaranteed for 2 years. Price: $3835.

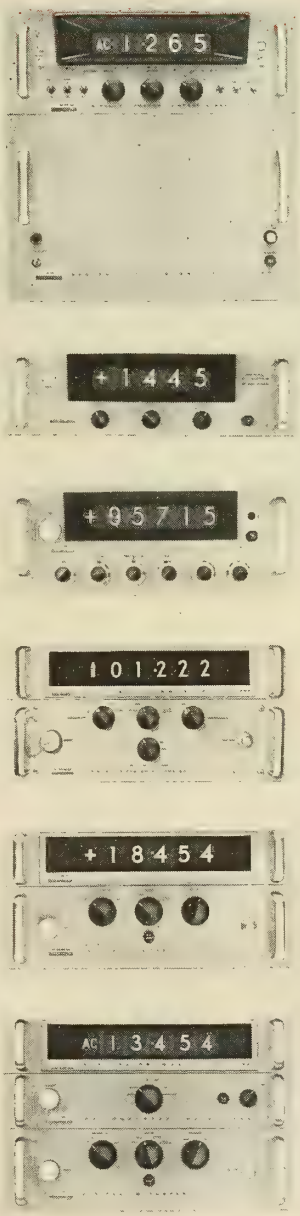
DC Digital Voltmeter (Model 501B). Four-digit, fifth-digit over-ranging. Measures positive or negative DC between 100 microvolts and 1000 volts, with 0.01% (of reading) ±1 digit accuracy. Automatic or programmable range; auto polarity. Combines the useful accuracy of a 5-digit voltmeter with the stability, reliability, and price advantage of a 4-digit voltmeter. Stepping switches guaranteed for 2 years. Price: $2995.

DC Digital Voltmeter (Model 501BZ). Similar to Model 501B (see above). Circuit is automatically and continually calibrated against a Zener diode reference source instead of against an unsaturated mercury-cadmium standard cell. For submarine and other special environment applications. Price: $3160.

AC/DC Digital Voltmeter (Model 502B). Gives you AC accuracy within 0.1% *of reading;* over-ranging on both AC and DC; automatic ranging and remote (programmable) control. Measures DC between ±100 microvolts and ±1000 volts, AC from 30 cps to 10 kc between 1 millivolt and 1000 volts. Five-digit readout. Stepping switches guaranteed for 2 years. Price: $4245.

AC/DC Digital Voltmeter (Model 502BZ). Similar to the Model 502B (see above). Circuit is automatically and continually calibrated against a Zener diode reference source instead of against an unsaturated mercury-cadmium standard cell. Price: $4410.

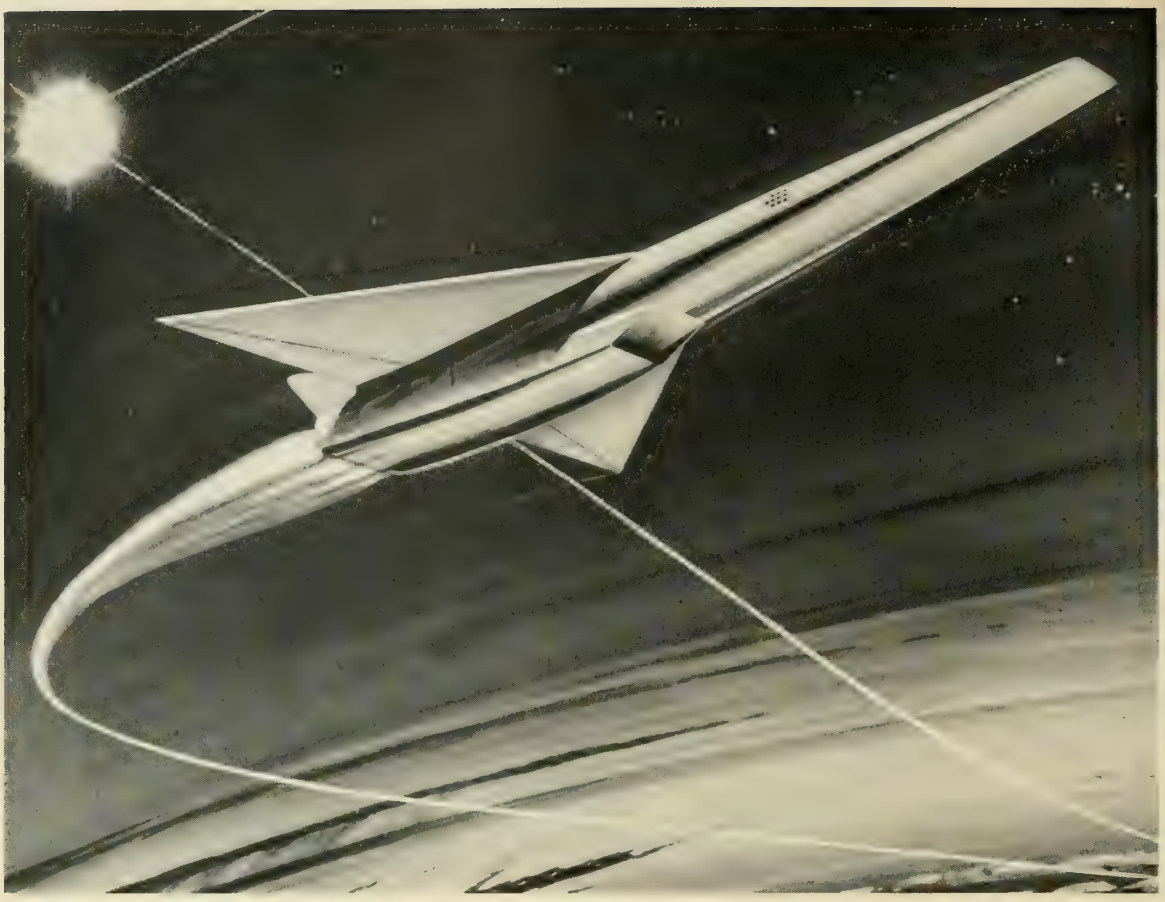
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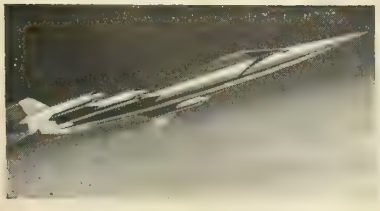
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The Hypersonic Fighter pictured above is only one example of many advanced concepts. Others—illustrated below—are:

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The Countdown

WASHINGTON

Big Booster Dispute Under Way

Air Force wants to skip the 156-in. solid booster and go directly to a motor in the 240-269 in. range. NASA, opposing this, wants to fund development of both. A decision, which will hinge on how much weight AF is able to swing in top-level discussions, is expected within two weeks. Contract, which will be the next major award in the large solid-propellant motor program, may be let within 90 days.

Base Activation Slowdown Looms

Air Force's Ballistic Systems Division already is concerned about possible delay in its fast-moving *Atlas F* activation program as a result of grounding of the C-133 transport. BSD employs C-133B's to carry missiles and transporter-erectors to the six *Atlas F* sites. A grounding order of even one week's duration could force movement of missiles over highway routes—an expensive and time-consuming operation.

Report on Centaur Is Due

Watch for a scorching report on the *Centaur* program from a House Space subcommittee within the next two weeks. It will take both NASA and the Air Force to task for delays in the liquid hydrogen upper stage program. Replacement of *Centaur* with another booster will depend on results of its second launch, now set for October.

The Military Classification Game

Want to try your hand at guessing what secret satellite the Air Force launched from Vandenberg AFB on June 1? The booster was a *Thor-Agena B*. Payload was classified. On June 2, AF disclosed that the piggyback radio satellite *Oscar II* had been launched the previous day; but it refused to name the launch site or the booster. Last Dec. 12, *Oscar I* was placed in orbit from Vandenberg AFB aboard *Discoverer XXXVI* with a *Thor-Agena* booster.

INDUSTRY

Solid Cartridges for Titan II

Aerojet-General engines for Martin's *Titan II* will employ solid cartridge charges to start turbine fuel pumps. This is a switch from the nitrogen bottle used in the first stage of *Titan I* and the helium bottle used in the second stage. Reason for changeover: more storability and quicker reaction.

Mercury Tracking Award Due

Announcement is expected from Goddard Space Flight Center shortly on whether contract for management of five tracking stations in the *Mercury* network will go to Bendix or RCA. Contract will cover 1963-64. Bendix now holds temporary contract which extends through the end of this year.

Shower Bath for a Titan

During activation of the first *Titan I* squadron at Lowry AFB, Colo., the hydraulic firefighting system in one of the silos was turned on with three men in the silo. The armed guard on the re-entry vehicle escaped injury from the 22,500 gpm flow by scrambling down the emergency ladder. Two drenched workmen at the bottom of the silo took shelter under a launch platform beam until the water was shut down.

INTERNATIONAL

New Aircraft for Skybolt?

Published reports in Britain say the Royal Air Force is studying a new long-range low-altitude aircraft as a follow-on to the Vulcan/*Skybolt* system. Carrying two of the Douglas ALBM's, the aircraft would be capable of flying more than 4000 mi. at 50 ft. altitude at almost supersonic speed, according to the reports.

NASA Studies Far East Locations

NASA is considering three locations for its new Far East tracking station: Japan, Okinawa and the Philippines. If built in Japan, the station probably will be erected by a Japanese firm and manned by Japanese technicians. Despite this, strong opposition in Tokyo may force NASA to select one of the other sites. No decision will be made until after July 1.

Blue Streak Tests in Britain

Final static tests of the British *Blue Streak* booster now are in progress at Spadeadam, Cumberland. When these are completed, the missile will be shipped to Woomera, Australia, for its first launching. Work on the program has been stepped up since the go-ahead for the European Space Launcher plan (ELDO).

Hawk Missile at Colomb-Béchar

Tests of two European-built *Hawk* missiles at the Hammaguir Test Base were successful, according to the French Ministry of the Armed Forces. The Raytheon-designed Hawks intercepted *CT-20* target missiles at an altitude of 2.5 mi. and at a distance of 8.7 mi. The test was the first undertaken with *Hawks* assembled in Europe. One of the two used was built in Italy, the other in France.

Prolonged Spaceflight by Russia?

Several papers published recently in the Russian Zhurnal Neorganicheskoi Khimii (Journal of Inorganic Chemistry) may be connected with a program for manned spaceflights of long duration. They deal with the reaction of sodium peroxide, sodium superoxide, potassium peroxide and potassium superoxide with water vapor, carbon dioxide and carbon monoxide. These all are reactions which might form the basis of atmospheric purification and regeneration systems.

New British Guided Weapons Chief

Air Marshal E. M. F. Grundy took over as Britain's Controller of Guided Weapons and Electronics on June 1. He formerly served as Commandant General of the RAF Regiment.

Questions and Answers about the

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The Missile/Space Week

Shots of the Week

A *Polaris* missile flight-testing a new lightweight guidance system was destroyed about 90 seconds after launch from a land pad at Cape Canaveral June 4.

"Following ignition of the second stage," a Defense Department announcement said, "a malfunction occurred, causing the vehicle to veer off course."

It was the second flight-test of the lightweight guidance system. The first, on May 3, was successful.

Earlier, the Navy successfully fired a *Polaris* from the submerged nuclear-submarine USS Thomas Edison. The missile, launched June 2 off Cape Canaveral, flew some 1500 miles.

The Edison is on its final shakedown cruise before being deployed.

In other shots:

• The Army successfully fired its *Pershing* missile June 4 to a range of about 200 miles in a severe test of the missile's guidance system. With 50-mph winds programed into the system, the missile rose from its Cape Canaveral launch pad with "a definite tilt" before the guidance system righted the *Pershing* for its downrange flight.

• *Oscar II*—launched by the AF for the American Radio Relay League June 1—is broadcasting on a frequency of 144.993 megacycles. Orbiting the earth every 92 minutes, the 10-lb. satellite is expected to broadcast for a month. Details of the launch site, time of launch and orbit were not disclosed by the Air Force.

A *Thor-Agena B* launched into a successful orbit from Vandenberg AFB, Calif., June 1 carried with it the *Oscar* payload. Although no details were given, the vehicle was another in the *Discoverer* series.

• A *Blue Scout* was launched from Pt. Arguello, Calif., May 31. Again, no details were disclosed.

• An *X-15* piloted by AF Maj. Bob White achieved a speed of 3750 mph and an altitude of 129,000 ft. in the severest test to date of the craft's re-entry performance at high entry angles at Edwards AFB, Calif., June 1.

Also tested in the flight was the emergency control system for the craft—proving that the backup controls would work at high speed and high angles of attack.

• A *Thor* booster—carrying a sub-megaton nuclear device for the initial shot of the U.S. high-altitude test series—was destroyed after liftoff from Johnston Island in the Pacific June 4. A terse Joint Task Force 8 announcement said that the booster was destroyed because the tracking system was malfunctioning.

MA-7 Overshoot Explained

NASA has listed three causes for the 250-mile overshoot by Astronaut M. Scott Carpenter during the *MA-7* flight.

The main trouble, the space agency said, was a 25-degree error in the capsule's "yaw" attitude at the time the retro rockets were fired to bring it out of orbit.

The capsule's nose end was canted 25 degrees to the right. As a result, the capsule was slowed somewhat less than would have been the case if the thrust had been directly opposite to the forward movement.

A NASA official said that the yaw error accounted for 175 miles of the 250-mile overshoot.

Two other factors cited:

• The retro rockets delivered about 3% less than the desired thrust. This was blamed for about 60 miles of the overshoot.

• The retros were fired about 3 seconds late. This accounted for the rest of the landing error.

U.S.-USSR Space Pact Near?

The U.S. and the Soviet Union appeared near agreement last week on their first effort at cooperation in space.

Soviet sources in Geneva reported that the two nations had agreed to launch a joint weather satellite as a result of talks there between Dr. Hugh L. Dryden, NASA deputy director, and Prof. Anatoly Blagonravov of the Soviet Academy of Science.

The same sources said agreement had also been reached on a joint program to measure the Earth's magnetic field, and a pact covering joint launching of a communications satellite was near.

In Washington, the State Department commented only that the talks had been "business-like and useful." A spokesman added the two negotiators would now report to their governments and it "seems likely" they would meet again. There was speculation that the next meeting might be in Moscow.

Circle No. 7 on Subscriber Service Card

AFOSR Lengthens Awards

The Air Force Office of Scientific Research (AFOSR) for the first time in its history is negotiating relatively long-term, basic research contracts with industry.

AFOSR's usual practice with industry is to work on the basis of one-year contracts which can be extended if the work demands it.

Three companies—Westinghouse Electric Corp., International Business Machines Corp., and Radio Corp. of America—will probably be awarded the first AFOSR three-year industrial contracts, according to Dr. Lloyd Wood, the agency's director of physical sciences.

Each of the three contractors is to share costs about equally with AFOSR.

Chief advantage of the long-term contracts is that basic research can be supported on a unit basis rather than on a one-year-segment basis; also, companies as well as AFOSR commit themselves to finance a complete study.

The three studies are concerned with the growth of single crystals of adequate purity and controlled properties. Total value of each contract, including contributions of companies: Westinghouse, $484,000; IBM, $320,000; and RCA, $279,000.

(See editorial, page 46.)

Non-Profit Probe Starts

The House Military Operations Subcommittee was scheduled to begin hearings on June 11 into government problems and solutions in contracting for technical and managerial services.

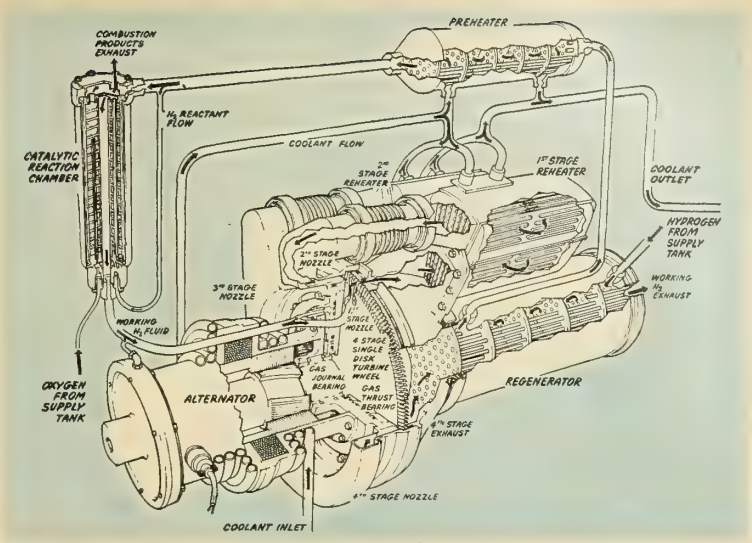
Headed by Rep. Chet Holifield (D-Calif.), the committee will "test the soundness" of the recommendations of the recently released Budget Bureau study on contracting in research and development.

BOB Director David E. Bell is expected to be the first witness. The subcommittee also wants to question DOD research and development managers, including the heads of nonprofit organizations.

Atlas F Turned Over to SAC

The first *Atlas F* missile complex was turned over to the Strategic Air Command at Vandenberg AFB last week.

Known as the 576D Site, the *Atlas F* complex will be used by SAC to train operational crews who will man the strategic missile sites. *Atlas F* squadrons will be emplaced at Schilling AFB, Kan., Walker AFB, N.M., Dyess AFB, Tex., Altus AFB, Okla., and Lincoln AFB, Neb.



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This is the Sundstrand CRYHOCYCLE . . . a cryogenically fueled, fully integrated power generation and thermal control system. Sundstrand developed the turbine driven CRYHOCYCLE under a U.S. Air Force Systems Command contract. Powered by hydrogen and oxygen, the CRYHOCYCLE is unique in that normally wasted heat from energy conversion inefficiencies and even metabolic heat from the crew is recovered by the coolant loop and returned to the power cycle by interstage reheaters between each of the four stages of a single-disc turbine. Sundstrand has also developed a multi-stage reciprocating version of the CRYHOCYCLE for low power levels. This concept results in specific fuel consumption economy which has not been achieved by any other dynamic space power system. As a result fuel weight and volume are reduced. In addition, the CRYHOCYCLE operates at room temperature eliminating need for high temperature materials, solving wheel containment problems, and greatly improving inherent reliability and safety. Since the CRYHOCYCLE is independent of the environment, it is ideal for Lunar missions. ■ The CRYHOCYCLE is a sensible size, too. About the size of a gasoline lawn mower motor, it can be used in pairs for maximum reliability. ■ Several versions of this space power system are being developed which will be suitable for missions of several weeks' duration . . . at power levels from one kilowatt to 50 kilowatts. Both the turbine prime mover (shown) and the reciprocating machine have been publicly demonstrated to representatives of the aerospace industry and government service. ■ (A simple request on your business stationery and we will send you details concerning this and the other accessory space power systems which Sundstrand has under development.) ■ If you would like to work on the Sundstrand Engineering team in the development of practical solutions to challenging space power problems, write to: Personnel Director,

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Savings envisaged . . .

NASA Leaning to Lunar-Orbi

Many top officials reported in favor of changeover from Earth-orbit plans; decision awaits completion of study

NASA IS MOVING toward a decision to select lunar-orbital rendezvous for the first American manned landing on the Moon.

The probable switch in plans, which would scrap Earth-orbital rendezvous, was revealed by a top White House space adviser.

The official told MISSILES AND ROCKETS that "while some flexibility remains, it now looks that way."

Informed sources also reported that many of the NASA officials charged with making the final decision now favor the lunar-orbit scheme.

This is buttressed by a recent statement to M/R by D. Brainerd Holmes, director of NASA's Office of Manned Space Flight. "A combination of rendezvous and direct flight," Holmes said, "looks very good." Lunar-orbit rendezvous meets that qualification.

A single *Advanced Saturn* would be used to send the *Apollo* spacecraft into lunar orbit. A two-man "bug" would then descend to the lunar surface. After takeoff from the Moon, the bug would rendezvous with the *Apollo* for the return journey.

Dr. Robert L. Seamans, associate spage agency administrator, refused to confirm or deny the reports.

He admitted, however, that the new flight mission was being given serious consideration.

Seamans said that the current NASA study of possible *Apollo* missions will not be completed until July 1.

"Until that time, it would be premature to say which lunar mission is favored," he continued.

There is one possible reason for the spage agency's reticence. In testimony before Congress, NASA has based its Fiscal '63 budget request on the use of Earth-orbital rendezvous for the primary Project *Apollo* mission. On that basis, the House has already approved a $3.6-million authorization bill.

Senate consideration will begin shortly.

• **What it would mean**—One thing is certain. A switch to lunar-orbit rendezvous would have vast ramifications on NASA funding and the entire U.S. space program.

Some of the possible effects include:

—The size of the *Apollo* spacecraft's lunar landing module would be cut by about 90%. Previously it was estimated that the module would have to weigh 100,000 lbs. to lower the spacecraft to the lunar surface.

The small two-man ferry in lunar-orbit rendezvous would weigh between 4000 and 14,000 lbs.

—The command and service modules also would be modified slightly. The command module would be changed so that the "bug" could hook up with it during the rendezvous phase. The service module would be lengthened slightly to provide room for more fuel.



DRAWING depicts size difference of giant lunar-landing payload of Earth-orbital rendezvous, small two-man lunar lander of lunar-orbit rendezvous.

—Total cost of the space program would be sharply reduced. The reduction in size of the lunar propulsion module also would mean a reduction in cost. Space agency officials earlier estimated its total worth at 50% of the total $3-to-$5-billion cost of *Apollo*. Only one *Advanced Saturn* booster would be used, compared to two in the Earth-orbital concept and one giant *Nova* booster in direct flight. As a result, it is also possible that the number of *Advanced Saturn* launch pads at Cape Canaveral could be reduced from the currently planned four to perhaps two.

—George M. Low, director of spacecraft and mission in NASA's Office of Manned Space Flight, recently said that once a decision is made NASA should devote all its resources, funds and manpower to it—and that nothing should be wasted on a backup plan. This could mean further delay in a start on the development of the giant *Nova* booster.

• **Pros and cons**—The selection of the primary mission for Project *Apollo* has been the subject of a sharp intra-agency fight between the NASA centers charged with major responsibility with the program.

The lunar-orbit concept has been pushed by the Manned Spacecraft Center in Houston, Tex. Opposing it has been the Marshall Space Flight Center in Huntsville, Ala.

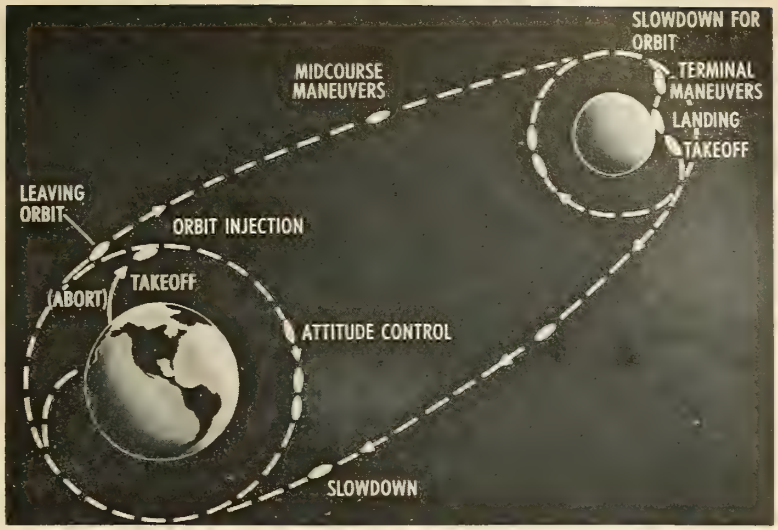
The launch vehicle team under Dr. Wernher von Braun contended that the use of one *Advanced Saturn* booster to launch the *Apollo* spacecraft from the Earth into the required lunar orbit might exceed its operational capability.

The *Advanced Saturn* has a planned escape payload of 75,000 lbs. NASA estimates that the command and service modules will weigh about 50,000 lbs., leaving the remaining 25,000 lbs. for the lunar landing bug.

Marshall held, however, that not once in the history of the U.S. space

endezvous

by Hal Taylor



SOME PROPULSION requirements for lunar-orbit rendezvous mission. Not shown are rendezvous of lunar bug with orbiting modules and firing out of lunar orbit for return.

program has a launch vehicle's operational capability been achieved. The Center's officials said that either the vehicle performance is below par or the payload weight is increased.

The feasibility of the lunar-orbit rendezvous is strongly defended by Dr. John C. Houbolt of the Langley Research Center.

Dr. Houbolt, reporting the results of detailed NASA studies of the mission, declares that it offers the advantages of reduced Earth escape weight, use of only a single moderate-sized launch vehicle, and increased chances of a safe landing on the lunar surface.

• **The sequence**—Here is how the *Apollo* mission would be accomplished, according to the NASA official:

One *Advanced Saturn* would be used to launch the spacecraft's command and service modules and the two-man vehicle into a parking orbit around the Earth. The third stage of the big booster would then be fired to send the payload on a trajectory to the Moon. The service module propulsion system would then be used to brake the spacecraft's speed so that it could go into lunar orbit from 50 to 100 miles.

Once in a lunar orbit, the two-man vehicle would disconnect from the spacecraft and, using a storable liquid propellant system, begin the descent to the lunar surface. One astronaut would remain in the command module. After the lunar landing, it would launch from the Moon and rendezvous with the orbiting spacecraft.

The two-man crew would return to the command module and the lunar-landing vehicle would be jettisoned. The service module propulsion would then be used to send the spacecraft on its return trip. Prior to re-entry, the service module would also be jettisoned. ⁂

OSO I Uncovers No New Hazards for Lunar, Interplanetary Flight

AMERICA'S FIRST Orbiting Solar Observatory (OSO) turned up no new roadblocks to manned space flight to the Moon and the planets.

Dr. John Lindsey, Project Director at the Goddard Space Flight Center, said that OSO I recorded only one cosmic-ray solar flare. This is the solar phenomenon which space scientists believe may be a hazard to astronauts.

The NASA official said that preliminary study of data from the spacecraft indicated that perhaps one other lethal flare was encountered among the hundreds of solar flares recorded during its 77-day lifetime. The rest, he said, were optical flares which would not harm man.

Lindsey's comments were made as NASA announced that OSO I had ceased transmitting useful information back to Earth, following over 1000 orbits and 200 miles of scientific data tape.

OSO I was successfully launched from Cape Canaveral on March 7, 1961. On May 22, after 1138 orbits, a malfunction in the spin control system prevented the spacecraft from sending any further meaningful data.

Lindsey said that the spacecraft flight "was successful." He said that during the month of March, 144 solar flares were encountered. The total number will grow sharply when all of the scientific data for the last 50 days of its orbital lifetime are broken down.

Analysis of the data will shed valuable light on the environment man will find on long space flight missions. The study will take several months.

• **Two-a-year schedule** — *The opportunity for additional information will be provided early next year, when OSO II is expected to be launched. A third spacecraft launch is scheduled for late 1963. After that, one launch every six months through 1965 is contemplated by NASA.*

The malfunction in its spin control system caused the OSO satellite to spin-up to a point where the servo system could no longer orient the scientific instruments and the solar cells towards the Sun. The servo system, in attempting to orient the solar-cell array to the Sun, is using large quantities of power; the batteries are in a continually discharged stage and, therefore, little useful information can now be obtained from the spacecraft.

During its 11 weeks of near-perfect operation, the extremely complicated satellite transmitted almost 1000 hours of scientific information on solar phenomena. OSO observed and measured more than 75 solar flares and subflares, mapped the sky in gamma radiation, examined energetic particles in the lower Van Allen region, monitored the Sun in a broad region of X-ray and gamma radiation, and performed surface erosion studies of various kinds of materials. Until the spin circuitry malfunction, OSO suffered no apparent degradation of performance.

The Orbiting Solar Observatory is a project managed by NASA's Office of Space Sciences and the Goddard Space Flight Center. The spacecraft was built for NASA by Ball Brothers Research Corporation, Boulder, Colo.

For Fiscal '63 . . .

Four States Get ⅔ of NASA Budget

FOUR STATES will get $2.2 billion, or almost two thirds, of NASA's Fiscal 1963 $3.7-billion budget request.

The lion's share, almost $1 billion, will be spent in California, according to space agency estimates.

The shares of the three other leading states include Florida, $543 million, Louisiana, $395 million; and Alabama, $341 million.

In addition, NASA will spend over $100 million in six other states—Texas, Missouri, New York, Ohio, Maryland and Virginia.

Thirty-one other states will be the recipients of space agency procurement of $1 million or more. Nine states, located primarily in the Midwest and New England, get no funds.

The heavy geographical concentration of space agency spending was revealed by a NASA chart (below) presented to the House Space Committee.

The breakdown includes a NASA estimate of how much it will spend in each state during Fiscal 1962 and Fiscal 1963. It is based on prime contract awards, construction of facilities and salaries and expenses. No subcontracting information is included. ⌘

(In thousands of dollars)

State	Total		Salaries & Expenses		Research & Dev.		Const. of Fac.	
	1962	1963	1962	1963	1962	1963	1962	1963
Alabama	224,964	341,935	60,000	70,370	138,110	234,028	26,854	37,537
Alaska	2,225	1,805	—	—	980	1,805	1,245	—
Arizona	3,941	7,262	—	—	3,941	7,262	—	—
Arkansas	44	80	—	—	44	80	—	—
California	523,922	947,767	23,050	29,207	459,289	830,704	41,583	87,856
Colorado	26,592	58,646	—	—	26,592	58,646	—	—
Connecticut	6,575	12,116	—	—	6,575	12,116	—	—
Delaware	76	140	—	—	76	140	—	—
Florida	209,878	543,262	5,600	6,500	94,857	174,799	109,421	361,963
Georgia	5,247	9,669	—	—	5,247	9,669	—	—
Hawaii	294	542	—	—	294	542	—	—
Idaho	—	—	—	—	—	—	—	—
Illinois	7,772	14,323	—	—	7,772	14,323	—	—
Indiana	2,221	4,092	—	—	2,221	4,092	—	—
Iowa	1,535	2,828	—	—	1,535	2,828	—	—
Kansas	—	—	—	—	—	—	—	—
Kentucky	54	100	—	—	54	100	—	—
Louisiana	48,016	395,352	458	1,750	46,578	359,102	980	34,500
Maine	—	—	—	—	—	—	—	—
Maryland	84,499	146,685	27,516	43,425	47,463	78,480	9,520	24,780
Massachusetts	16,437	30,290	—	—	16,437	30,290	—	—
Michigan	13,074	24,092	—	—	13,074	24,092	—	—
Minnesota	3,200	5,898	—	—	3,200	5,898	—	—
Mississippi	22,590	95,000	—	2,500	—	—	22,590	92,500
Missouri	107,260	264,898	—	—	107,260	264,898	—	—
Montana	—	—	—	—	—	—	—	—
Nebraska	—	—	—	—	—	—	—	—
Nevada	15,087	40,160	—	—	87	160	15,000	40,000
New Hampshire	54	100	—	—	54	100	—	—
New Jersey	22,631	41,704	—	—	22,631	41,704	—	—
New Mexico	2,340	4,313	—	—	2,340	4,313	—	—
New York	82,785	152,553	—	—	82,785	152,553	—	—
North Carolina	5,254	3,941	—	—	239	441	5,015	3,500
North Dakota	—	—	—	—	—	—	—	—
Ohio	79,346	163 619	30,682	43,250	46,754	75,536	1,910	44,833
Oklahoma	610	1,123	—	—	610	1,123	—	—
Oregon	359	662	—	—	359	662	—	—
Pennsylvania	20,661	38,073	—	—	20,661	38,073	—	—
Rhode Island	152	281	—	—	152	281	—	—
South Carolina	—	—	—	—	—	—	—	—
South Dakota	—	—	—	—	—	—	—	—
Tennessee	1,709	3,149	—	—	1,709	3,149	—	—
Texas	111,557	135,284	7,314	30,304	44,243	73,225	60,000	31,755
Utah	54	100	—	—	54	100	—	—
Vermont	—	—	—	—	—	—	—	—
Virginia	116,948	171,436	43,738	43,632	58,653	102,030	14,557	25,774
Washington	174	321	—	—	174	321	—	—
West Virginia	2,500	1,500	—	—	2,500	1,500	—	—
Wisconsin	1,263	2,327	—	—	1,263	2,327	—	—
Wyoming	—	—	—	—	—	—	—	—
District of Columbia	44,430	85,848	18,392	29,826	26,038	56,022	—	—
Various Locations	9,420	34,000	—	—	—	—	9,240	34,000
Total	**1,827,750**	**3,787,276**	**216,750**	**300,764**	**1,292,905**	**2,667,514**	**318,095**	**818,998**

Repeat of '61 . . .

New McNamara List May Alter Budget

Secretary urges 'reverse pyramiding' of R&D award to cut costs; space project titles classified

by James Trainor

A COMPREHENSIVE list of study projects distributed to various Pentagon offices by Defense Secretary Robert S. McNamara last week is expected to have a major impact on the Fiscal Year 1964 military budget.

Ranging across the spectrum of defense activities, the project list contains approximately 85 specific study areas, about one-third of them classified. Military space projects were classified.

The new list complements a similar study program initiated by McNamara shortly after he took office last year. In March, 1961, he distributed a list of more than 100 areas of immediate concern; after studying the results of the study effort he made substantial changes not only in the FY '63 budget requests but also in the military force structures.

"With hindsight," the Secretary said in announcing the new list, "it appears to me to be a useful administrative technique."

Specific results of the previous study effort included the decision to initiate the joint Navy-Air Force TFX aircraft development, reorganization of the Army's technical services and the establishment of the Defense Supply Agency.

Although Secretary McNamara refused to assign priorities to the various projects on the new list, he singled out several for comment and discussion.

• **Reverse pyramiding**—One of these was the study to "develop procedures in research and development which will allow multiple competitive approaches to technology, followed by a smaller number of approaches to systems development, and a still smaller number of production items directed toward a given use. The aim would be to maximize choices and lower costs by cutting off non-competitive developments as soon as enough is known to do so."

Using the *Medium-Range Ballistic Missile (MRBM)* as an example, the Secretary said the concept envisioned in the study directive would be to increase the effectiveness of R&D by engaging in a reverse pyramid of application.

In other words, the Air Force would not issue a development contract for the *MRBM* as the first response to the operational requirement for the system. Rather, it would initially determine alternative weapon system characteristics. Also, it would determine alternative companies which on a short-term basis (30-180 days) would perform duplicatory study work on the methods of accomplishing the various alternative specifications.

This effort—constituting a broad base of 5-10 companies—would be narrowed down as a result of the preliminary work until ultimately a development contract would be let.

Denying that this approach would result in any difficulty with industry, McNamara said it would meet "one of industry's major criticisms."

"In the past," he said, "there have been many instances where a large number of companies—far too large a number in relation to the capabilities of the companies or the requirements of the job—have been invited to submit full weapons system proposals."

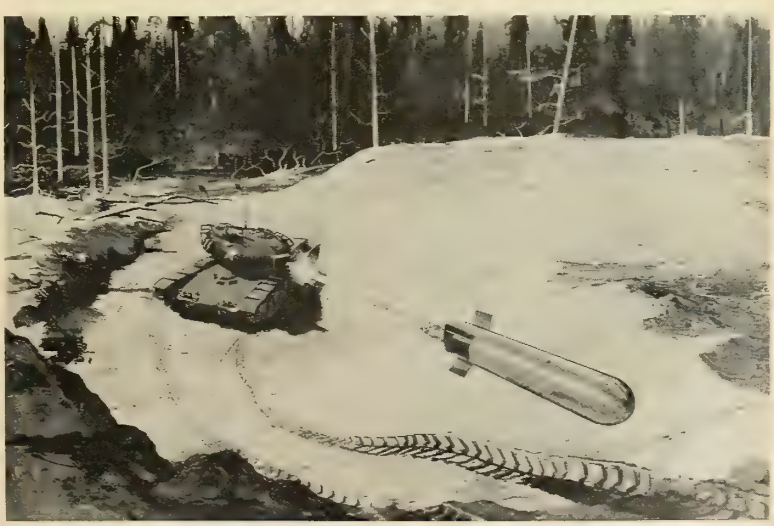
After the system has been in effect for a time, he feels that "industry will find it very helpful rather than the reverse."

• **Secrecy**—Commenting on the classification of some of the project titles, the Secretary said that simply the knowledge that DOD was undertaking certain studies would be of assistance to potential enemies. Citing particularly studies of the application of advanced technologies to weapon system development, he said that "the lead time that would be given to our application of such technology to weapons in itself would be a valuable asset."

Other classified studies relate to the normally classified areas of operational plans and strategies.

The majority of the 80-odd studies, the Secretary noted, will be completed during the third quarter of this calendar year. However, some will not be finished before the first quarter of 1963.

(Continued on page 16)



Shillelagh Depicted for First Time

ARTIST'S CONCEPT newly released by Army and Ford Motor Co. shows launch of Shillelagh surface-to-surface guided missile. Shillelagh is being developed by Ford's Aeronutronic Div. Raytheon is subcontractor for fire control.



RECOVERY of payloads may be 75% faster with amphibious helicopters than with hovering craft. This is Sikorsky S-62 turbine-powered craft used in test.

Payload Recovered By Water-Landing Chopper

NASA for the first time has used a water-landing amphibious helicopter to recover an instrumented payload returning from space.

Space agency officials declared that they were pleased with the experiment. They indicated that future use was likely and even said there was a chance the method could be used for astronaut recovery.

The successful test was made on May 25. A Sikorsky S-62 turbine-powered amphibious chopper recovered a 213-lb. instrumented nose cone 52 miles downrange from Wallops Is., Va.

The recovery method including water landing was proposed by Helicopter and Airplane Services Corporation (HASCO) of Washington, D.C.

The items recovered from the ocean by the S-62 consisted of the instrumented nose cone, the recovery parachute and flotation equipment which housed a SARAH homing transmitter. The nose cone, ten feet long, was manufactured by Aerojet-General and launched by an A-G *Aerobee* booster. Its descent was slowed by a 24-ft. parachute which was deployed at approximately 18,000 feet altitude upon re-entry.

The helicopter used for this recovery is the commercial version of the HU2S-1G helicopter being procured by the U.S. Coast Guard. Recoveries of personnel from the water during the Coast Guard-Navy evaluation of this helicopter showed that recoveries could be made in approximately one fourth of the time required for recoveries using the various hoisting methods from a hovering helicopter.

HASCO and Sikorsky Aircraft, on a NASA contract, participated in the recovery operation, along with the NASA Range Recoverer ship, a U.S. Coast Guard boat, a UF-2G amphibious airplane and NASA's Lewis Research Center R-4d aircraft. The S-62 helicopter utilized for this recovery was equipped with a SARAH receiver, a rescue hoist, communication and navigation equipment as well as other special equipment needed for this type of operation.

The technique utilized in the recovery was based upon the amphibious helicopter's ability to land and maneuver on the water, rather than hover above the object being recovered. This allows the helicopter crew to quickly and safely recover the payload and return it to shore. This method of recovery, according to NASA, should also prove to be valuable in recovery of personnel or manned capsules from the water as the helicopter crew can provide rapid on-the-spot assistance.

Valuable payloads which may become too heavy for the helicopter to lift due to flooding or damage need not be jettisoned as they can be supported by the type of helicopter due to the tremendous excess buoyancy of its amphibious hull. ⌗

(Continued from page 15)

• **Assignments**—The list of unclassified projects called on specific DOD agencies to:

—Examine the management organization of research and engineering in each of the military departments, with the emphasis on eliminating unnecessary echelons, improving channels of communication and reporting and cost control procedures on a DOD-wide basis, and recommending improved cost controls as well as increased performance and reduced lead time.

—Review all major development projects (*Midas, Dyna-Soar, Advent, Zeus,* etc.) and report action which can be taken to better achieve the project objectives and to reduce the project costs.

—Arrange for the Joint Staff to prepare a detailed analysis of NATO's *MRBM* requirements.

—Develop an effective approach to NATO weapons requirements determinations, joint research and development and production projects and logistics support.

—Prepare a detailed study of the requirements for General Purpose Forces.

—Prepare a program to reduce the complexity and improve the reliability of Navy ships and weapons systems.

—Develop a series of quantitive measures of progress being made to improve the performance, cost and schedule performance on R&D contracts—including improved program definition; use of incentive contracts; quantitative measures of contractor performance as a basis for awards of fee and additional or new work; control of changes; simplification of specifications; and elimination of unnecessary features and requirements.

—Translate the five-year Force Structure and Finance Program into a five-year production program for defense industries and research organizations. Present the program both in terms of industries and geographic regions.

—Analyze the impact of the five-year R&D program upon the availability, distribution and utilization of scientific and engineering manpower.

—For the 10% of the economy which DOD influences, lay out a detailed program for anticipating and softening the effects of shifts in type and volume of procurement and R&D.

—Prepare plans for formal organization within the Joint Chiefs of Staff for continued study and analysis of:

a. Nuclear strategy and requirements for strategic nuclear weapons and invulnerable command and control.

b. General-purpose forces requirement and requirements for tactical nuclear weapons. ⌗

SNAP-50 Mainly In-House Project

Details of nuclear reactor program released— power operation scheduled to begin in spring of 1965

THE ATOMIC Energy Commission will lean heavily on its in-house laboratories in moving ahead with the high-power *SNAP-50* program.

This was revealed during the 1962 Nuclear Congress held in New York last week, when additional technical details about the *SNAP-50* program were released. This program has been under investigation as duplicating some aspects of Air Force and NASA work (M/R, Feb. 19, p. 12).

The AEC's national laboratories will be used to the maximum extent to support the *SNAP-50* program, Col. William A. Tesch told the congress. He added that advanced work in high-temperature materials, liquid-metal technology, and reactor physics being pursued at Oak Ridge National Laboratory, Brookhaven National Laboratory and Argonne National Laboratory will be of direct benefit to the advanced space reactor effort.

ORNL, which has been working in the nuclear space power field since 1958, will be the principal supporting laboratory for the *SNAP-50* program, said Tesch.

• **The goals**—He stated that the overall objective of the *SNAP-50* program is to provide an advanced system in the late 1960's. Pending determination of specific power levels, he said, the reference design point is at the 1 mwe level which requires a thermal rating of 8 to 10 megawatts. The design goal for the *SNAP-50* system is a specific weight on the order of 10 lbs./kwe (unshielded) which includes the reactor, the conversion unit, and the heat rejection radiator. Perhaps the most important design criterion is reliable, unattended operation for a period of 10,000 hours.

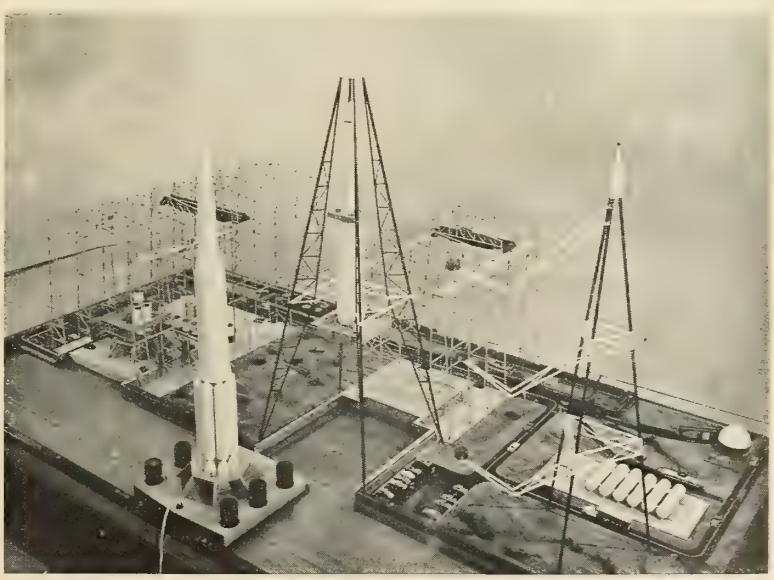
The *SNAP-50* design concept, he reported, is a two-loop system employing a lithium-cooled reactor integrally coupled by means of the heat exchanger to a high-temperature vapor turboelectric conversion system.

The turbine working fluid is expected to be boiling potassium, which appears attractive at the design temperature conditions.

Because of their high fuel density and thermal conductivity, uranium monocarbide fuels are an obvious design choice; however, Tesch added, additional irradiation data are needed, and are in the process of being obtained, before design commitments can be made. Considerable data are available, however, on the oxide fuels. Both UO_2B_eO and UO_2 show promise of long endurance and satisfactory performance at some expense in reactor size and weight. Since the powerplant will be operating at high temperature, the use of refractory metals will be required throughout the system.

The AEC's lithium-cooled reactor program provides the basic framework of technology, facilities, and trained personnel for the *SNAP-50* reactor program, he continued. The lithium-columbium technology has advanced to the point where it is now possible to operate successfully forced convection loops, scaled pressure vessels, and other structural tests at temperatures of 2000 degrees for many thousands of hours. The translation of this technology to the 10 mw thermal lithium-cooled reactor experiment is in the stage of advanced development and component testing, with fabrication of the experiment scheduled to begin in the near future.

Initial criticality for the experiment is planned for the fall of 1964; power operation is scheduled to begin in the spring of 1965. The experiment will be a test of the reactor and primary loop, using a conventional heat "dump" with no provision for power conversion equipment. ⌘



Aerojet's Floating Launch Pad

WORKING MODEL of "Aeropad" shows Aerojet-General's concept of assembly, transport and launching of kiloton-size space boosters. Vehicle is assembled on pad resting on the bottom of a canal connecting assembly and launching sites. Water pressure is used to raise the pad, and entire rig is floated to launch site. Company estimates $3 million would build a Nova-class pad system.

No change likely . . .

Dispute Over Nuclear Tests Increases

UN Secretary General joins opposition, citing protests by many scientists; the AEC stresses advantages

CONTROVERSY continues to mount over the current U.S. high-altitude nuclear tests in the Pacific—in spite of Administration assurances that there is "no need for concern regarding any lasting effects on the Van Allen belts and associated phenomena."

A group of American scientists including Dr. James A. Van Allen of the State University of Iowa, discoverer of the belts, have endorsed the Administration's stand. But scientists opposing the tests got a boost last week when U Thant, Secretary General of the United Nations, roundly condemned the test series.

"I feel that these projected high-altitude tests are a manifestation of a very dangerous psychosis which is in evidence today," U Thant told a news conference. Noting that he supports the UN resolutions banning nuclear tests, the Secretary General put the high-altitude tests in a different and "more undesirable" category.

"In the first place," he said, "these tests, when announced, were objected to very vigorously by many eminent scientists all over the world, and scientists with no axe to grind.

"Secondly, it is common knowledge that space is no country's territory. It is the common property of all countries."

This second point brought support from the New York *Times*, which editorially raised the question "of the right of any nation to act unilaterally in such matters."

"If it is true that such tests are made necessary by the demands of our national security," the editorial said, "the question still remains whether or not our national security would not be better served by consultation with an international body of scientists in the free world."

(Such a consultative body was created by the Committee on Space Research [COSPAR] just prior to the adjournment of their meeting in Washington last month to preclude "potentially harmful" experiments from being conducted in space [M/R, May 21, p. 10].)

• **A precedent**—U.S. officials, however, have refused comment on the controversy—beyond the initial White House justification of the tests which was issued May 28. Similar tactics have been used in the past—particularly on the scientific protests last year about the *Westford* experiment.

At this time a group headed by Jerome P. Wiesner, the President's Science Adviser, studied the probable effects of orbiting 350 million dipoles, concluded that the experiment would not have lasting effects and issued their findings. Once issued, the statement became, and remains, the basic justification for the experiment.

The same procedure seems to apply to the protests over the high-altitude tests. The determination has been made that the tests will not have lasting effects, therefore it is extremely unlikely that the renewed protests over the tests will have any effect on the program.

• **Thor blown up**—The test series got off to an unfortunate start June 4, when a *Thor* carrying a sub-megaton device was destroyed by the Range Safety Officer, only a minute and a half before it would have reached the detonation altitude of about 50 miles.

The failure of the first test is expected to make certain the addition of a fourth high-altitude test. Previously, the AEC had announced that, "depending on the results of (the scheduled three tests), a fourth shot may be fired at an intermediate altitude (M/R, June 4, p. 12)."

Refurbishment of the *Thor* launch pad is expected to take approximately two weeks. Therefore, the second nuclear test—"a megaton device" to be exploded at an altitude of about 500 miles—is not expected to be ready for launch until next week at the earliest.

The third test will be in the sub-megaton range and will be detonated at about the same altitude as the second.

It is these two tests that have raised the most controversy. Critics of the tests assert that the explosions will seriously, and perhaps permanently, distort the Van Allen belts before scientists have a chance to explore them fully.

Admitting that the tests will, in fact, "cause a perturbation to the existing natural radiation belts," the AEC and Administration experts contend that "any disruption of the inner belt is expected to disappear within a few weeks to a few months."

• **An opportunity**—Rather than being concerned about the effects of the tests, the AEC announcement says, scientists will have "an opportunity to obtain important scientific data regarding the physics of the upper atmosphere including the nature and cause of the Van Allen belts."

In an effort to assure scientists a maximum opportunity to observe the effects of the tests, Joint Task Force-8 has instituted procedures to notify scientists throughout the world of the date and time of a high-altitude test.

In addition to ground instrumentation, satellites are being used to provide data on the effects of the explosions. At present, *Injun* and *TRAAC* are expected to provide data on the changes in particle densities from the explosions.

Explorer XIII, to be launched this summer, will supplement these measurements. Also, several of the "secret" satellites launched from the California coast over the past month are expected to provide valuable information to Defense planners on the effects of the explosions on space vehicles.

Effects of the explosions on radio and radar communications are one of the main concerns of the Defense Department. Enough was learned from the *Orange* and *Teak* shots in 1958 and the *Argus* experiments conducted during the same year to alert Defense experts to the disruptive effects of high-altitude explosions on communications and their possible use to "blackout" early warning systems.

In addition, the neutron propagation distances in space are of critical importance to anti-missile-missile systems —particularly, the Army's *Nike-Zeus*, which uses a nuclear kill mechanism.

For these reasons, the Administration has determined that the tests are necessary and should be carried through in spite of scientific protests. In light of divided scientific opinion as to the effects on the Van Allen belts, it is unlikely anything will change this decision.







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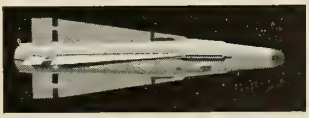
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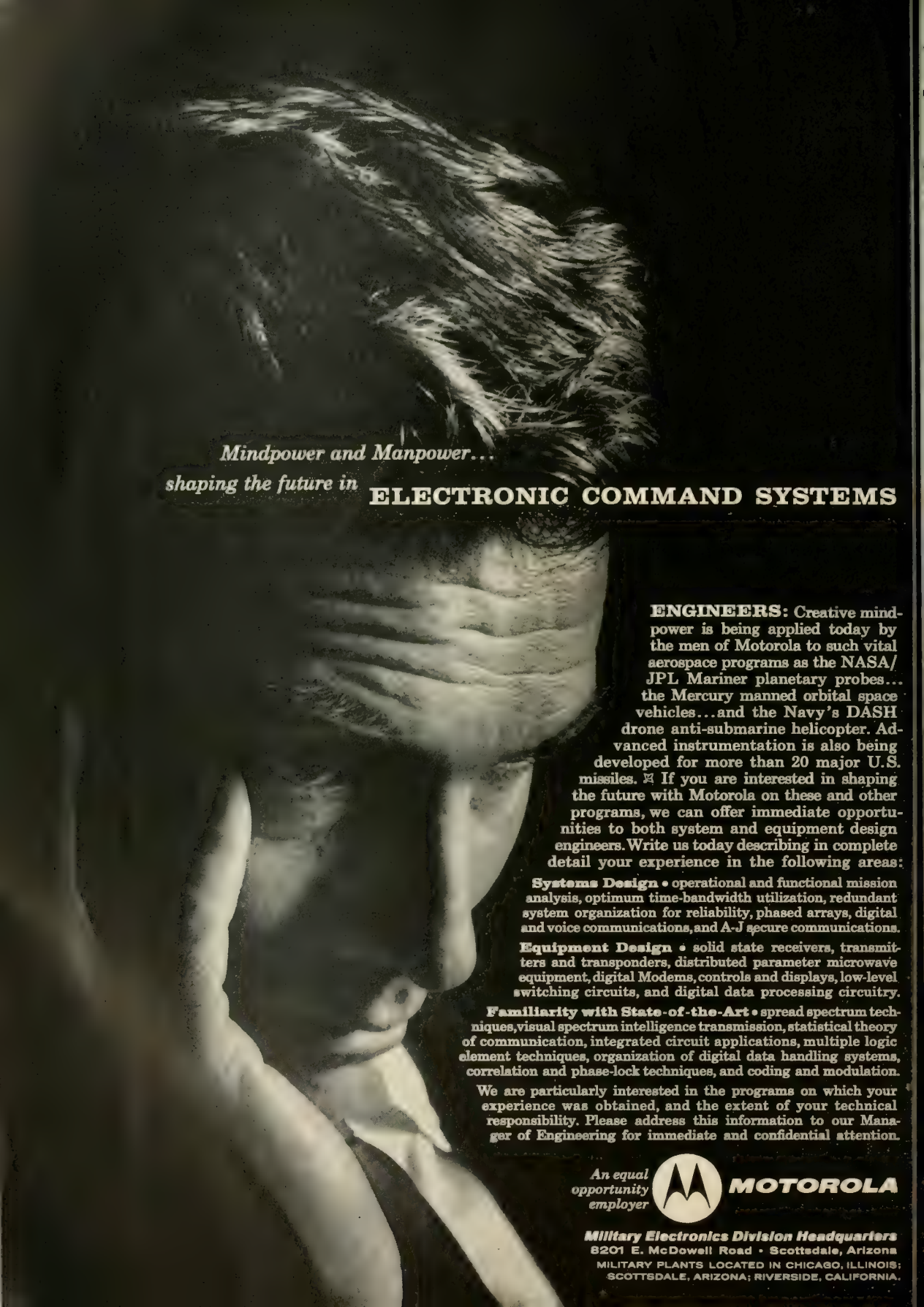


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Technical Countdown

ELECTRONICS

Ultrasonic Delay Line R&D Extended

Corning Glass Works has developed a photoelastic ultrasonic delay line having variable delay from 0-100 microseconds. Center frequency is 16 mc. and overall bandwidth exceeds 10 mc. Using a fiber-optics readout, the device has a signal-to-noise ratio of 25 db, the company reports. Under a continuing R&D contract with Rome Air Development Center, Corning will strive to build a single line having 1000 separate light responders and reduce tap spacing to 0.01 microsec. of time delay. The existing model has 0.1 microsec spacing for six consecutive fiber bundles, each feeding into a photo-multiplier.

Biggest Missile/Space ADP Center?

Lockheed Missiles & Space Company, with the addition of another IBM 7090 digital computer late in June, may have the biggest computer center in the industry. It now has three IBM 7090's fed by ten IBM 1401's. Over 900 data-processing people are now employed by the company at its Sunnyvale, Calif., plant.

STINGS Selection Near

AC Spark Plug Division of General Motors and General Precision's Kearfott Division have each received a nearly $1½-million add-on for continued development of STINGS, Stellar Inertial Guidance System. To be used in the Air Force *MMRBM*, the system is now the object of competition between the two contractors. A selection of one of the two is expected within the next several months, insiders say.

Newest Gyro Builder Revealed

Martin Co.'s Space Systems Division reports it has developed a new gas gyro (the division's first) for the TGAM-83 *Bullpup* trainer missile that may help cut guidance system costs by nearly 75%. Now in production after two years' development, the gyro has a total of 16 major parts and 6 bearings. The inertial unit reaches 17,000 rpm in less than ⅓ sec. after firing, Martin says. The 2.5-lb. gyro measures 3.75 in. dia. x 6.75 in.

High Speed Computer Developed

Hazeltine Corporation has designed a parallel digital differential analyzer that operates at a rate of 10^6 iterations/second. Called SPEDAC, the solid-state computer can be married readily to analog equipment. Because of its unusually high speed, it is expected to find wide application in solving missile and satellite tracking problems requiring a uniform degree of accuracy.

ADVANCED MATERIALS

Thermo-Chemical Technique Bonds Refractories

Martin-Orlando researchers have perfected a bonding technique for refractory metals which avoids the recrystallization problems associated with welding. In the process, filler refractory material is deposited in the joint by the combined nucleation and reduction of refractory-bearing halogen gases. Heat is applied to the base sheet, but the temperature is kept below 1500°F. The method results in a filler material with a somewhat dendritic but fine grain structure having a hardness level equal to the base metal.

Explosive Safety Manual Compiled

A comprehensive safety manual covering high-energy compounds, explosives, propellants, pyrotechnics and related materials from small-scale lab experiments to full production has been prepared by the White Oak Naval Ordnance Lab. The book includes material from four other Naval activities and 12 industrial firms engaged in explosives R&D. The compilation is reported to be the first to include the sequence of operations required in the development of new explosive compounds.

Russians Using Plasma Guns

The USSR has reportedly developed a plasma torch with temperature capabilities in excess of 15,000°C. The unit produces a thin plasma stream for cutting refractories such as silicone carbide and ceramic plates. The torch is argon-cooled, and its "most important" use is said to be in the field of refractory and heat-resistant materials for rockets.

NASA Developments Opened to Industry

Metal specialists in the *Saturn* program at Huntsville have perfected a magnetic metal forming process reported to be especially useful for swaged fittings. As a swaging tool, magnetic pulse working shrinks metal with less springback than any other method, giving a stronger joint. . . . A silent "clunkless" solenoid valve developed for missile fueling systems has been simplified to the extent that it can be used in home and industrial gas furnaces. The valve is oil-damped. . . . A stirred arc gas heater consisting of a high-intensity arc passed between two doughnut-shaped, water-cooled electrodes may be of interest to the chemical processing industries. The unit uses an external magnetic field to spin the arc at 400 rpm, preventing electrode burn and upping the efficiency 50%. The arc can heat gases to 5000° and provide enthalpies up to 2000 Btu/lb. High-temperature reactions can be investigated with the device.

Solar Simulators Poorly Designed?

"All current solar simulation experiments are being done on a catch-as-catch-can basis, and simulator design is based on 'ill-defined requirements'," according to Alfred Landau, president, Aerospace Controls Corp. Laudau recently told a meeting of the Institute of Environmental Sciences that no uniform requirements for solar simulation have been defined to date. He said that in some instances designers have either overlooked some of the basic physical considerations or didn't know them in the first place. Also, specs too often are based on environmental test procedures established years ago for aircraft, he declared.

Rocket Motor Internal Burning Photographed

Technologists at the White Oak Naval Ordnance Lab have developed a cinefluorographic method for photographically recording the internal burning of rocket motors during static tests. The system examines the motor using an X-ray source on one side and, on the other a 9-in. light intensification tube coupled to a 35mm camera. During a test, the X-rays penetrate the rocket and form a picture on the intensification tube. The camera records the changing internal dynamics of the motor.

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A.C. Spark's Metrology Investment

Reflecting precision Space Age demands of industry, new labs house fifty major devices of extreme accuracy

by Charles D. LaFond

MILWAUKEE—The recent dedication here of A.C. Spark Plug's extensive new metrology facilities served to further emphasize the almost incredible precision required by missile/space manufacturing. It also pointed up one of the reasons today's more successful guidance-system prime contractors are all members of big business—it's a costly burden to bear.

Occupying more than 5700 sq. ft. are two primary metrology labs and their associated secondary or working laboratories. Together, the electrical and mechanical labs possess more than 50 of the most up-to-date measuring devices available. In some instances, these major instruments equal or surpass accuracies achieved by the National Bureau of Standards.

The General Motors division has been assembling its collection of instruments for over 12 years. Now, for the first time, these invaluable tools are installed under one roof in precisely controlled environments.

Nearly 200 leaders in industry, government, and the military attended the formal opening of A.C.'s new laboratories. Dr. Allen V. Astin, director of the National Bureau of Standards, was principal guest speaker.

• **Specialized labs**—The facility actually is comprised of three major laboratories: mechanical, electrical (and radio frequency), and geodetic reference.

The 700-sq.-ft. mechanical metrology lab is located in a new aluminum clean room. Environmentally controlled, its temperature is held to within ±0.1°C when two specialists are at work inside the room. Four workers degrade this accuracy by about ±0.25°C. A 10-ton air conditioning unit is required to service the 7392 cu. ft. of space encompassed by the lab.

All the master mechanical measuring standards are contained in this facility, which is isolated on a concrete pad within the main plant.

A 1500-sq.-ft. working laboratory is adjacent to the primary lab. Here the sub-master or reference standards are available for calibrating the multitude of less precise measuring devices used in plant production.

The electrical metrology lab occupies some 1700 sq. ft. and has an associated reference lab covering an additional 1800 sq. ft. of area.

The third lab is really an observatory. It is a completely isolated 30 x 30 ft. domed pad housing a trio of collimators and an ultra-precise astrotheodolite. Each instrument is mounted on an isolated concrete column. The latter is used for determining and periodically verifying the precise local latitude and longitude and the true-North reference.

Via one collimator these data are directed optically to reference collimators within the main plant to align precision inertial elements for guidance systems.

• **Not-so-typical instruments** — A partial list of A.C. Spark's primary standards include:

A Moore Universal Measuring Machine measures parts up to 18 inches long within an accuracy of 10^{-6} in., and measures roundness of holes within 14×10^{-6} in.

A Tally-Surf (Surface Finish Measuring Machine), utilizing a sensitive magnetic pick-up and stylus, can measure spherical surfaces to 5×10^{-7} inch.

A Leitz Optical Dividing Head measures angles to within 2 seconds of arc.

A Wenner Potentiometer, developed by A.C. Spark, reads voltage directly from 0.11110 volt to 11.11110 volts to within ±0.002%.

A Unity Reactance Bridge also designed and built by the division, is capa-



LEFT: *Accurate azimuth reference for alignment of precision gyroscopes will be possible using this new Geodetic Reference Laboratory at A.C. Spark Plug's Milwaukee facility. Within the 30 x 30 ft. pad are isolated columns supporting three fixed collimators and a Kern astrotheodolite, capable of an accuracy better than 1 second of arc.*





DUBBED THE "SILVER DINER," this 700-sq.-ft. clean room houses all the primary mechanical standards. Temperature here is controlled to within ±0.1°C. A 10-ton air conditioner is required to filter and circulate air throughout the lab's 7392 cu. ft. of space. The aluminum facility is contained on an isolated pad.

ble of measuring capacitances four times better than previous equipment. This instrument actually measures beyond the standards set up by the National Bureau of Standards, the company asserts.

A Maxwell-Wein-Curtis Inductance Bridge built by A.C. after several years of development, is believed five times more accurate than any inductance measuring equipment on the market today.

A Daphne Potentiometer—the first to go over 4 volts—can be read to 8 places by interpolating galvanometer readings.

A DC Voltage Standard employing eight saturated cadmium-sulfide cells. Output of this unit, which uses an oil bath for temperature stability, has changed only 1 microvolt in over 8 years.

Hilger and Watts Interferometer that employs light waves to determine length of metal pieces to 10^{-6} inch. So sensitive is the instrument that it can measure the degree of expansion generated by the warmth of a human breath on a piece of metal.

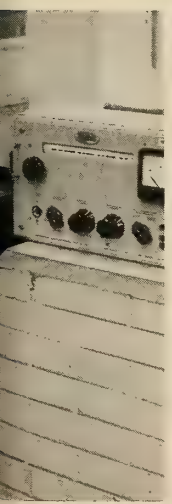
In addition to all of the metrology devices, other measurement facilities include weighing instruments that can determine the weight of a fingerprint; a centrifuge that can measure "G" acceleration to an accuracy of several parts in a million; particle counters that can measure dust particles to eight microns (a micron is 1/25,400 of an inch).

Metrology labs such as this are being slowly assembled throughout the missile/space industry today in an attempt to reach the ultimate in reliability and repeatibility in vital guidance systems.

Besides using its array of equipment for calibrating plant instruments, A.C. Spark often provides such services for some of its subcontractors.

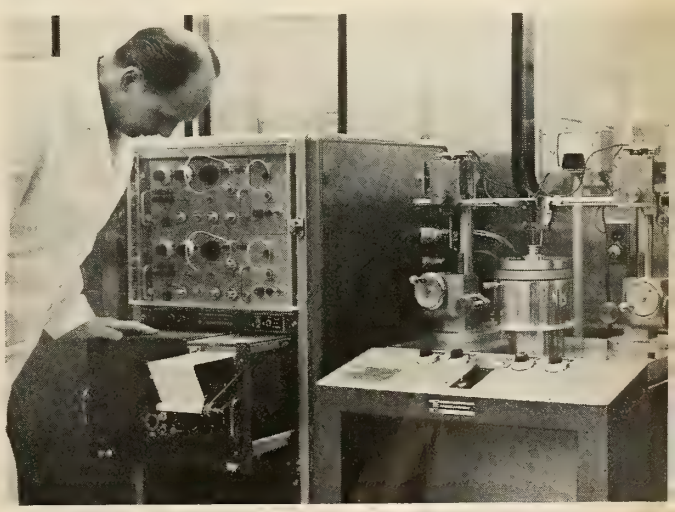
In time, officials say, these facilities may be made available to others in industry on a service contract basis.

Most of the instruments at this facility have contributed heavily to the development of precision gyros and accelerometers for *Thor, Titan II,* the *Polaris* submarine SINS system, and other guidance and navigation systems. A.C. Spark engineers feel the metrology labs will play another major role in the *Apollo* stable platform to be built by the division. ⌘



LEFT: *This Unity Reaction Bridge is believed by A. C. Spark standards experts to surpass the present capacitance issued by the National Bureau of Standards. Capable of measuring capacitances within accuracies of 0.005%, the bridge is represented as having four times the accuracy of previous equipment and ten times higher resolution.*

RIGHT: *One of three in the world is this Roundicorder, which can measure the roundness of a part to within 2 x 10^{-6} inch. Designed by General Motors Research Laboratories, the device is one of 50 major measurement standards comprising A. C. Spark's mechanical metrology lab.*



Present Technology Can Handle Advance

Vehicle, propulsion package development is far greater problem than guidance and navigation requirements

by John F. Judge

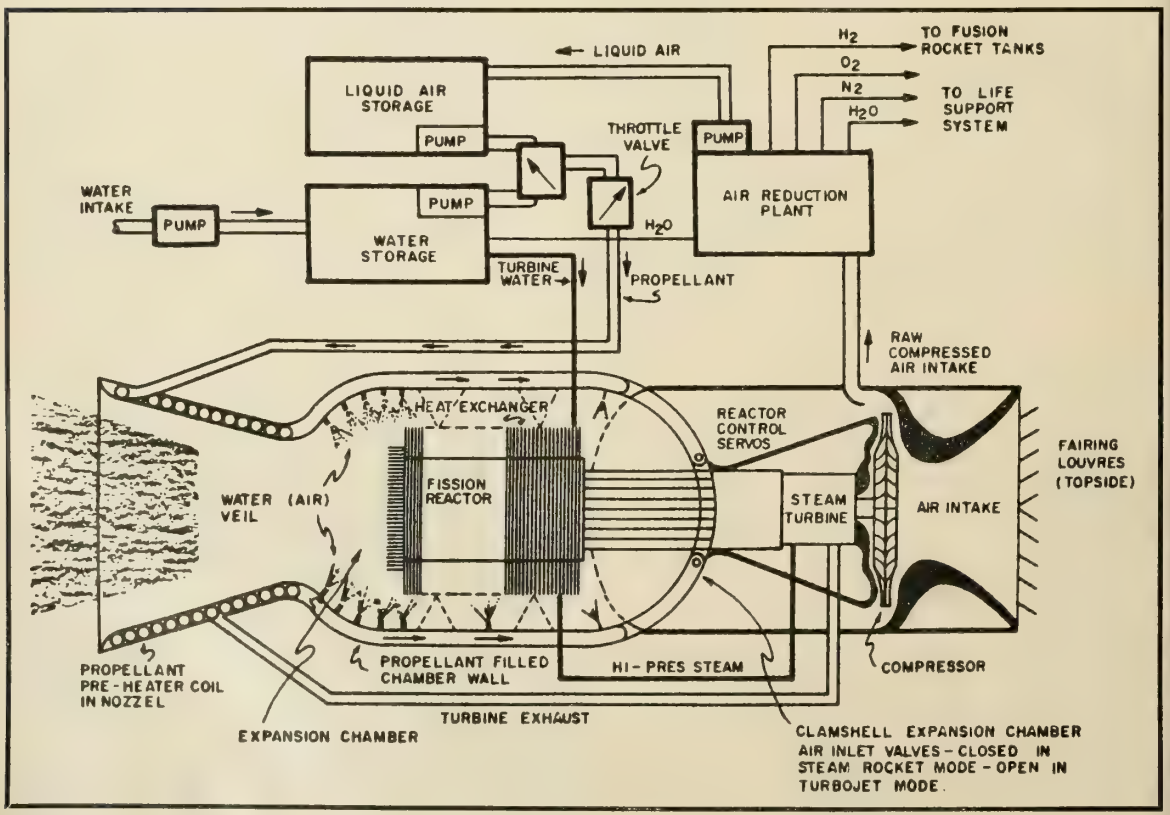
AN ELECTRONICS EXPERT says navigation and guidance sensor requirements for the most advanced nuclear aerospace craft conceivable present no great problems to current technology.

C. W. Benfield of Minneapolis-Honeywell's Military Products Group gave this confident assessment to a recent National Aerospace Electronics Conference in Dayton, Ohio. But he warned that the craft itself was something else again. Indeed, he declared, such super-ballistic flight systems "could only grow out of deadly serious competitions—such as interplanetary warfare or commerce."

If neither of these occurs, says Benfield, the advanced aerospace plane (advanced *ASP*) will never be a reality.

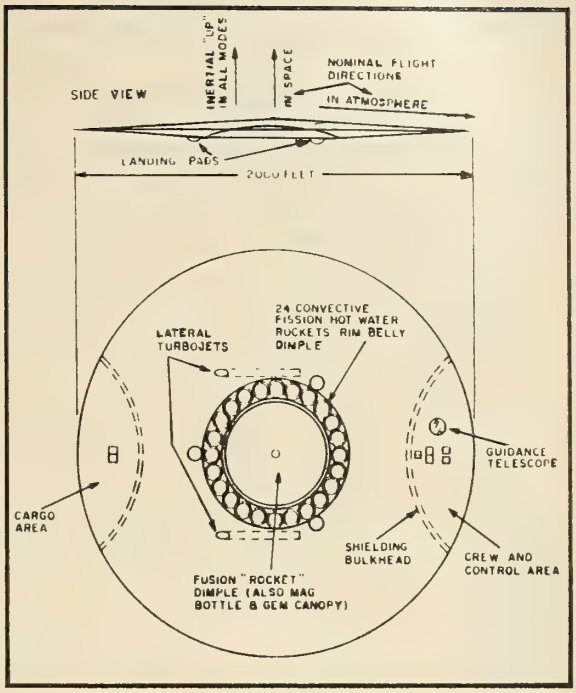
• **Propulsion**—Benfield reported that the propulsion system of the advanced *ASP* would be capable of operating in several modes:

—*Ground*—While parked on the planet's surface, the propellant tanks will be filled with water—either by pumping from the nearest source or through atmospheric condensation—or liquid air obtained directly from the atmosphere through on-board reduction equipment.



Hypothetical Convective-Fission Rocket/Turbojet

ASP Navigation



MASSIVE saucer-shaped craft represents an advanced ASP, a concept which carries all components to their ultimate—yet is within current navigation technology.

—*Low Altitudes* — Lift-off, hover and slow surface cruising might use the ground-effect lift. In this mode, says Benfield, liquid air or water may be injected into expansion chambers heated with a liquid metal working-fluid fission reactor arrangement. The principle is similar to that of present nuclear ships. Such rockets are called "convective fission rockets." The super-heated steam, or air, will expand through propellant-cooled nozzles directed downward into the canopy formed by the dimple in the lower hull.

Flame deflection by auxiliary jets will provide steering and balance, as well as lateral thrust.

Exhaust velocities are limited to less than 12,000 m/sec. by the low temperature of working fluids, and the high molecular weight of water or air.

—*High Altitudes*—Subsonic flight will be achieved in a flying wing mode using the lateral convective-fission turbojets. The convective support rockets are shut down gradually as wing lift develops. At about 30,000 ft. the ship begins to recharge its propellant tanks with liquid air condensate water collected directly from the upper atmosphere by the on-board reducing plant. Electrolytic decomposition of condensate and tank water permits filling the fusion rocket tanks with hydrogen.

• **Space** — When the propellant tanks have been completely filled, the convective rockets will fire briefly at full power to take the ship out of the atmosphere and up to orbital velocity. The use of convective fission turbojets and rockets for atmospheric flight and exit avoids atmospheric contamination.

Outside of the planet's atmosphere, a true nuclear fusion rocket might be employed to achieve thrust levels ten times those of the convective fission rockets. The belly dimple is the magnetic bottle area in which fusion of hydrogen into helium produces a temperature of about 10^{10}°K. Electric-fission plasma/jets also are a possibility for outer space propulsion.

Such a rocket engine could maintain continuous high thrust for many weeks, and when developed will open up the fascinating possibility of continuous-thrust, super-ballistic, interplanetary flight with 50% payload fractions. A typical velocity budget for a very slow (Hohmann) round-trip transfer to a Mars landing with Earth return is about 50,000 m/sec. This could just be handled by the convective fission rockets in a single-stage mode with a payload fraction of about 20%, assuming that the propellant tanks are reloaded with Martian air for the return trip, since such a rocket theoretically is capable of a characteristic velocity in the neighborhood of 25,000 m/sec.

Even without the true fusion rocket, says Benfield, an advanced *ASP* capable of single-stage, round trip flight to Mars or Venus still is conceivable. Such a flight would involve 260 days of zero-g conditions each way, however, putting physical and emotional stress upon the crew and imposing high accuracy requirements on the navigation system.

Benfield then considers the possibility of accelerating at slightly above one Earth "g" half way to Mars, and decelerating at the same value during the remainder of the trip. The travel time at favorable opposition would permit covering the 49,600,000 miles in about 50 hours, with an artificial on-board gravity of one Earth "g" all the way. This would be about as comfortable as spending 50 hours in a modern jet aircraft. The characteristic velocity requirement for such a trip is about 1,800,000 m/sec. The fusion rocket hypothesized might be able to carry itself and its 50% payload through this journey almost 14 times without re-fueling.

• **No re-entry heat**—The problems of high-speed re-entry would disappear entirely with such thrusting capability. The ship gradually would match the velocity of the target planet by lead-angle pursuit methods, and would settle gently into the atmosphere to fly as an aircraft to a soft, vertical landing.

The simplest aerodynamic hull configuration is hypothesized by Benfield as a flying wing of generally circular shape. This would be roughly equivalent to a pair of shallow cones-base-to-base, 2000 ft. in diameter and 100 ft. thick at the center—giving total volume of about 104,800,000 cu. ft. Assuming a take-off specific gravity of 0.1, the ship would float in sea water with the wing edges about 40 ft. above the surface, and would displace about 335,350 short tons.

Just to levitate over the surface would require a contra-gravity force of slightly over 670,700,000 lbs. Means other than rocket-like conservation of momentum might be applied for this initial lift-off; for example, an air cushion with 10.3 psi sustained pressure differential in the belly dimple area of 454,000 sq. ft. would support the ship by ground effect. The belly dimple is ringed by 24 convective fission rocket/turbo jets; each would contribute steam

or hot air to maintain the pressure in the dimple at 25.3 psia. A slight tilt—by increasing one rocket's flow—would move the ship in any direction desired at low velocity over water or ground. Lateral turbo jets would permit airplane-type take-off after a long run just over the surface.

To rise vertically from the surface with 0.01 g relative acceleration, 1.01 actual acceleration is required. The required vertical thrust would be:

$$F = (W/g)\,a + W$$
$$F \cong (2.086 + 6707) \times 10^5$$
$$\cong 670{,}900{,}000 \text{ lbs.}$$

Benfield calculates that each of the 24 rockets would have to develop a thrust of over 28 megapounds. This emphasizes the desirability of employing aerodynamic lift where possible. The fission rockets are assumed to be capable of about three times the thrust of chemical rockets of similar size, so each of the 24 is comparable in size to a 10-megapound liquid booster rocket.

• **Guidance**—The navigation system of the advanced *ASP* will not require high-accuracy position determinations. The navigator will use a large telescope arrangement to view the highly magnified image of the target planet with several known star images superimposed upon it by sextant-like, folded optics. Choosing a pre-calculated "lead angle," the ship begins steering a line-of-sight collision course by keeping the chosen star images positioned constantly upon center and limbs of the planet.

Drift of star images indicates rotation of the LOS in inertial space. The drift rate is observed with a pair of directional photo-sensors viewing the passage of the star. One gates a precise oscillator "on"; the second gates it "off" and the accumulated count in a register is inversely related to angular velocity of the LOS to the planetary surface feature.

Steering commands cause a simple attitude change to null-out all velocity normal to the LOS. The navigator works in spherical coordinates with the target planet at the origin. Since solar escape velocity would be exceeded during midcourse, a failure of the propulsion system could result in ballistic flight to the outer darkness. The midway thrust-reversal-point must be anticipated fairly closely—if rendezvous at zero relative final velocity is to be achieved without increased on-board "gravity". Knowing the altitude over the target planet at all times makes it possible to integrate the motor to predict "impact velocity if present thrust is maintained," and to throttle engines such that the predicted impact velocity is nulled continuously.

This implies thrust control—possibly by metering fusion reaction mass using convective-fission rockets as verniers. A fast-response accelerometer, pendulously suspended from the ship's frame, indicates thrust magnitude and is the feed-back element in the acceleration control loop wherein the engines are actuators. The missing element in such a control loop is the velocity sensor. Benfield lists two possibilities:

—Stellar aberration velocity meters —such as those described by Lillestrand while at General Mills and by N. Lozins of Honeywell Aero—are applicable. In these instruments, the velocity magnitude resolutions are estimated as 100 ft./sec. (Lillestrand) and 20 ft./sec. (Lozins). While not compatible with control of ballistic flight, such errors would be tolerable by comparison with the velocity and thrusting capability of the *ASP*.

Since final closure could be handled by present state-of-the-art radar altimeters, Benfield tentatively concludes that the worst problems of *ASP* navigation already have been solved (the guidance telescopes previously referred to involve nothing beyond 1962 optics).

—On-board, Doppler radars capable of ranging upon both origin and destination planets would have their "beam-zeros" referred to the star field in order to establish two "lines-of-position" whose intersection is bracketed further by two ranges. Integration between successive pairs of simultaneous fixes would be based on the relative velocity observed from Doppler shift.

Operation of such radar at microwave frequencies would require dishes of about 100 ft. diameter. In view of the estimated size of the *ASP* and the available on-board power, Benfield estimates that suitable radars might be built within five years, so that even this mode of navigation is within near future state-of-the-art.

Large as then envisioned *ASP* might be, the payload still is important, and the attitude-control thrust to permit torquing giant dishes could be better used if a much smaller radar-like device were available. The over-all performance requirements remain the same, but by shifting into the infrared or ultraviolet frequency range, very small "dishes" would suffice and beam width could be held to a few microradians with an analogous "high antenna gain," reducing the total power needed. The Hughes 'colidar' is a forerunner of such a laser guidance device.

Benfield feels that on-board, active optics in 1980 will be capable of observing ranges (5 mi.), range rates (10 ft./sec.), and star-referenced line-of-sight angles (20 arc/sec.), to all bodies in the solar system at any time during flight. Echo time lag considerations are included.

• **Thrust vectoring system**—In view of the velocities involved, the thrust vectoring servos must be capable of operating at extraordinarily high frequencies—on the order of 100 cps.—particularly for circumterrestrial flight. This would rule out such things as gimballed nozzles. The estimated operating temperature of the fusion rocket plasma is 10^{10}°F. and such a plasma could not be maintained in a material combustion chamber and nozzle. Some sort of magnetohydrodynamic configuration will be required. Electromagnetic deflection thrust vectoring looks best.

Benfield says the navigation and guidance sensor requirements present no insurmountable difficulties to present technology. But the vehicle itself is 20 to 40 years away, even if R&D efforts are continued at their present level. With total disarmament, nuclear research would be suppressed and the advanced *ASP* might not lift off for another 100 to 200 years.

The feasibility of nuclear rockets was being argued seriously prior to 1958. Those who dream beyond the day-after-tomorrow do not greatly doubt that the more exotic propulsion systems eventually will become a reality. The question of *when* is not a simple matter of necessity and funding, says Benfield. Technology must be at a state wherein such devices can be useful.

The progenitors of the essential *ASP* systems are in existence or designed for other uses now, as follows:

Propulsion—*Kiwi/Rover/Pluto.*

Air Reduction—Industrial air production plants.

Life support—Nuclear submarines.

Airframe—AVRO-Canada.

Guidance—Celestial/inertial systems for space craft.

Electrical Power Supply—Nuclear powerplants.

G.E.M. Hover—Various G.E.M.'s

Guidance Telescope—Major observatories/sextants.

Guidance Radar—D.S.I.F. at Jet Propulsion Laboratory.

Flight Control and Stabilization—Various missile and aircraft autopilots.

Thrust Vectoring—CR tube deflection/MHD pumping/fluid amplifiers. ⁂

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Ames Develops Lunar Flight Simulators

NASA center is deep in research on effects of lengthy confinement in Apollo, Gemini capsules

by Robert Lindsey

MOFFETT FIELD, CALIF.—NASA has launched a major study of man's capabilities and limitations for guiding *Apollo* spacecraft to the Moon.

New simulators that will duplicate all conditions of a lunar round trip except weightlessness and radiation hazards are being developed at the space agency's Ames Research Center here. With them, NASA will determine how best to integrate man into the *Apollo* guidance loop.

Test pilots will make long-duration lunar "flights" in the simulators to evaluate navigation systems and techniques and to anticipate problems in *Apollo* missions. Meanwhile, Ames' new Life Sciences Laboratory has begun extensive research on the biomedical aspects of the lunar flight.

Two scientists were recently encapsulated in a simulated *Apollo* vehicle for seven days to gather data on the physiological and psychological effects of confinement during long periods.

The research team is concerned over how lengthy confinement in a cramped *Apollo* or *Gemini* capsule will affect crewmen's ability to function, particularly to navigate. This is particularly important, of course, in the *Apollo* program: *Apollo* crewmen will have to worry about mid-course navigation, both en route to the Moon and returning. Hence, part of the program here is aimed at learning how little cabin space crewmen can get by with and still function efficiently.

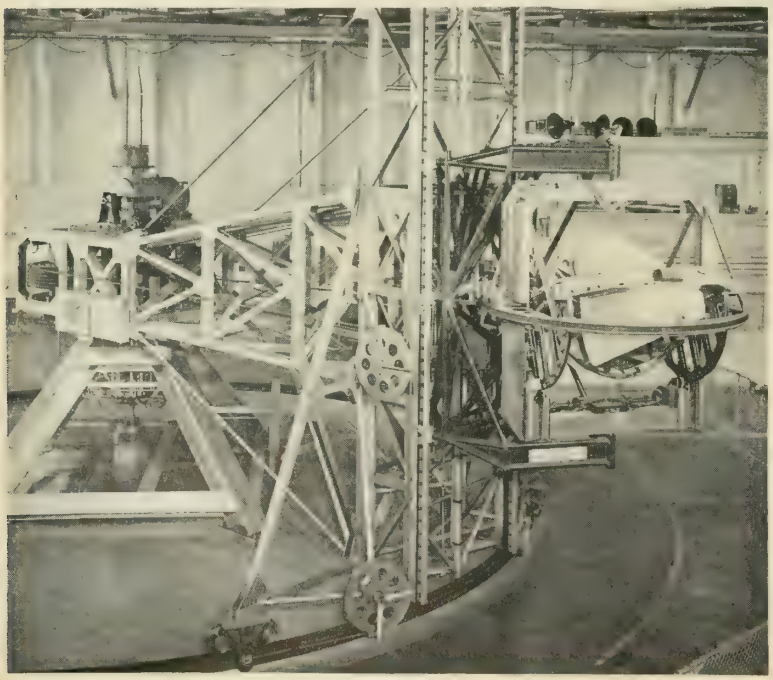


PHOTO SHOWS mechanism of five-degrees-of-freedom simulator in operation at Ames Research Center. Portion at right contains cab or cockpit pilot rides in.

Two simulators, one for studies of mid-course guidance problems, and one for *Apollo* re-entry studies, will go into operation in early summer or late spring. An advanced spaceflight guidance simulation facility which could be used not only for *Apollo* but for planetary space missions is being designed and is proposed under a $9.8-million item in the Fiscal Year 1963 budget.

Ames is providing research support to NASA's Manned Spacecraft Center, concentrating on mid-course navigation techniques, terminal and re-entry guidance problems and research on *Apollo* guidance components. No development of hardware is planned: Ames will study alternate approaches to guidance component design. MIT is *Apollo* guidance system contractor.

Using its extensive experience in aircraft flight simulation, Ames reported last week it is making early headway in devising systems to simulate lunar and planetary manned flight. These are the systems with which the *Apollo* research will begin soon:

—An "interim" mid-course simulator in which test pilots will attempt to navigate over eight-hour phases of the Earth-Moon trajectory.

—A five-degree-of-freedom simulator to test piloting problems during re-entry at the lunar return speed of 25,000 MPH.

• **Mid-course**—The interim mid-course simulator will consist of a three-man movable capsule suspended on an air bearing and a 35-ft. circular display wall, about 50 ft. away, on which are placed collimated lights simulating the stars and a mechanically driven Earth or Moon in front of the star background.

Test pilots in the capsule will make sightings on two chosen reference points—a star and the Moon or Earth —and feed these data into a simulated





LEFT: *A technician helps researchers get into Apollo capsule mock-up.* **RIGHT:** *Effects of seven days of simulated space flight are observed by Ames' Dr. Harald A. Smedal on TV. At left, Glen W. Stinnett, at right Dr. Terence A. Rogers.*

on-board computer, which will determine their position and dictate any velocity changes needed to get back on the programed course. Their controls will activate a simulated propulsion system to make the required velocity changes.

An analog computer will drive the whole system, continually changing the visual presentation to the crew—their instruments and the vehicle's apparent position relative to the stars, Moon and Earth—in response to the crew's controls.

The research should show how accurately astronauts can use star-planet sightings to guide themselves to the Moon and what kind of instrumentation they will need to do it. Test results should be easy to evaluate—if the crewmen navigate a safe course to the Moon, their technique and system is good; if they don't, it's not. The simulator should provide a means to effectively evaluate competitive approaches to lunar flight navigation.

Since Ames' investigators want to know if and how the rigors of the long lunar trip impair astronauts' ability to navigate, the crew's performance will be studied under differing environmental stresses.

Movement of the Earth and Moon will simulate the long-term movement of the spacecraft as it heads toward or away from the Moon. Sensations of short-period motion will be introduced by reaction control jets which spin the vehicle in pitch, roll and yaw axis as it "floats" on the near-frictionless air bearing. The slow oscillation of the vehicle which can be expected on the lunar flight will be duplicated.

The crewmen will be required to control the spacecraft's attitude precisely during at least two key periods—when they are shooting their position and when they ignite their propulsion system to make velocity changes.

Analytical studies by Ames' guidance group indicate that a star shooting accuracy of 5-20 secs. arc is necessary for effective mid-course position location. This is about ten times the accuracy achieved by mariners. Ames engineers expect the simulator to show position of the Moon and Earth relative to the stars with an error of less than 5 secs. arc accuracy.

The visual presentation of the interim simulator, limited to showing celestial geography of only eight-hour periods of the flight at one time, is changeable to simulate all phases of mid-course navigation in the seven-day lunar round trip.

• **Re-entry**—For its *Apollo* re-entry studies, Ames is adapting its five-degree-of-freedom simulator from its current assignment in the supersonic transport research program.

This simulator consists of a one-man cabin, mounted on a three-axis housing, which revolves around a circular track. It can introduce four of the six quantities of motion simultaneously, either three angular and one linear, or three linear and one angular. Also driven by an analog computer, the simulator will duplicate the control problems which *Apollo* crewmen will encounter when their spacecraft plunges into the atmosphere at 25,000 MPH.

Control problems caused by different return trajectories and different vehicle configurations will be presented to the pilots as the research team seeks the best combination of vehicle and trajectory for the crucial re-entry phase.

Besides producing data on the piloting problems, the simulator will be used for studying physiological effects of the rapid deceleration of a lunar flight re-entry.

• **Advanced facility**—Design of the space guidance facility now before Congress is not final, although a basic concept has evolved. Part of the system is envisioned as a large, hemispheric planetarium showing the Sun, Earth, Moon, certain planets and all stars down to the fourth magnitude, plus an air-bearing mounted three-man capsule with pitch, roll and yaw freedom. More realistic cues will be used in the interim simulator, and the crewmen will be able to make simulated trips over the entire Earth-Moon gap, plus planetary voyages.

Also proposed for the new spaceflight guidance facility is the next-generation simulator for studying re-entry problems. This will be a dual-purpose system with interchangeable three-man capsules mounted at the end of a whirling 50-ft. arm. Ames engineers stress that it would not be a centrifuge in the conventional sense but a mission simulator which imposes acceleration stresses as part of an overall environment.

Two different capsules would be used, one to study guidance and human performance during re-entry, and one for use by the Life Sciences Laboratory for research on the human system.

Through simulation, the system would integrate guidance, stabilization, control and other subsystems to provide data on the interactions of the entire unit and would be capable of duplicating all flight conditions except weightlessness and radiation hazards. Whether the crew will do any celestial navigation during re-entry is doubtful, one Ames engineer said, because once he has entered his re-entry corridor the pilot will be committed and be too busy piloting the vehicle.

The Life Sciences group plans to subject crewmen to temperature extremes, impact and oscillatory movements, noise, humidity and other stresses to study the conglomorate effect of these conditions during spaceflight. If it works as planned, the Life Sciences system will be capable of providing accelerations of 7½ g/sec. to 50g maximum with a one-minute duration for the 50g mode. ❖

New Cells Due for Heavy Space Duty

Nickel-cadmium units produced in NASA-sponsored pilot plant use ceramic-to-metal seals, non-woven nylon

by Michael Getler

METUCHEN, N.J.—Pilot plant production has begun on a series of lightweight hermetically-sealed nickel-cadmium storage batteries destined for use in several upcoming U.S. space ventures.

The batteries, developed here by Gulton Industries, Inc., will power systems aboard NASA's *Orbiting Astronomical Observatory* and *Orbiting Geophysical Observatory* vehicles, DOD's *ANNA* geodetic project, and two ARPA programs—*Arents* and *Vela Hotel*.

One of the first batteries to come off the pilot production line has already made a successful debut aboard the *UK-1* satellite launched late in April.

The Gulton development effort, supported by a $200,000 contract from the Goddard Space Flight Center which included establishment of the pilot plant, is aimed at turning out quantities of a maximum reliability device for extended space probe applications. The Goddard award comes under the space agency's space power and advanced technology program.

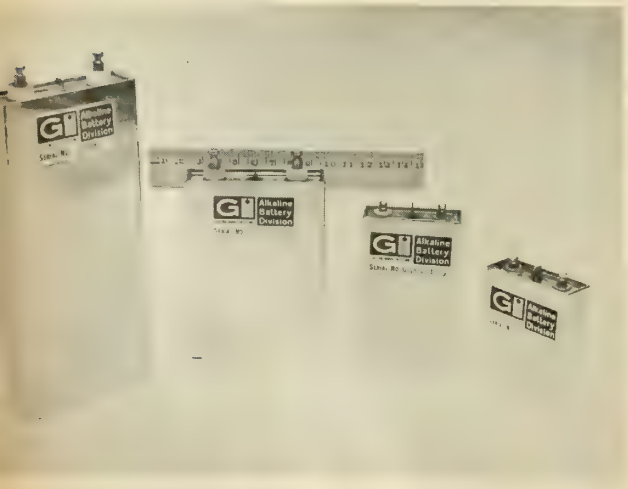
Currently the plant is producing four cell sizes rated at 3, 6, 12, and 20 ampere-hour nominal capacities. About 200 of the batteries are turned out each month, mostly in the three larger sizes. The four nickel-cad batteries weigh .39 .62, 1.15, and 1.9 lbs., respectively, and have outputs equivalent to 12-15 watt-hours per pound.

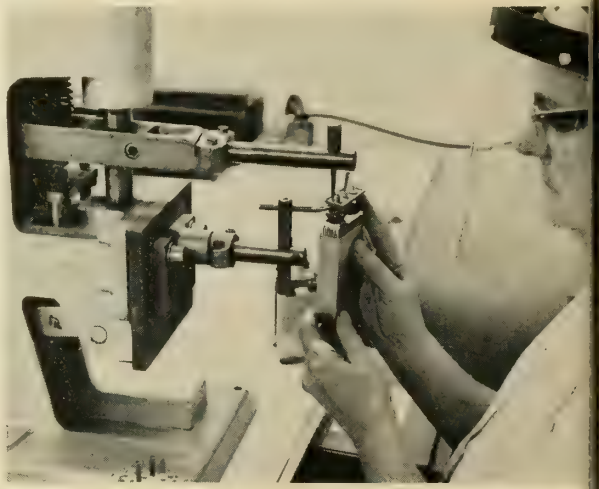
The units, according to Gulton scientists, are capable of operating in a space environment for at least two years under fairly deep discharge conditions, exhibit gaseous leakage rates below the 10^{-8} cc/sec. of helium which is said to be the maximum tolerable value for extended space operations, and can be continuously overcharged in orbit with no excessive build-up of internal cell pressures and therefore no requirement for auxiliary charge limiting apparatus.

• **Ceramic-to-metal seals**—The stringent leakage requirements for the hermetically-sealed container are being met through the use of heliarc welding for final cell closure and a new ceramic-to-metal seal used to isolate one or both of the cell terminals from the stainless steel case. Gulton scientists believe this is the first time ceramic-to-metal seals have been used effectively on nickel-cad batteries, though they have been used previously on much smaller areas to seal electronic components.

Engineers on the project feel that the use of the aluminum-oxide ceramic constitutes a significant advance over glass-to-metal sealing techniques and hermetic pressure-type seals which use plastic gaskets such as rubber or Teflon. The Gulton seal reportedly showed leakage rates of less than 10^{-9} cc/sec. of helium after a week-long exposure to a severe caustic cell environment.

Cell leakage rates are checked just before final closure through a small pinch-off tube which is eventually welded to complete the seal. The cells are tested again for leakage after final closure. About 5% of helium is left inside the cell after the sealing operation is complete.





LEFT: *Four small and lightweight cells are currently being turned out, rated at 3, 6, 12 and 20 amp-hr. nominal capacities.* *A 7-amp-hr. silver-cadium unit has also been developed.* **RIGHT:** *Welder connects assembly to cell cover.*

In addition to the ceramic-to-metal seals, Gulton scientists feel another significant improvement in the state-of-the-art is exhibited by the non-woven nylon material which is used as the battery separator. This, together with careful attention to precise amounts of the potassium hydroxide electrolyte and the length of the diffusion path between electrodes, gives the battery its continuous overcharge conditions. The internal cell pressure reportedly will not exceed 35 psi.

In the Gulton design, when the cell becomes fully charged, the oxygen which tends to form at the positive electrode remains dissolved in the electrolyte and diffuses through the separator toward the negative electrode. Here a chemical reaction converts it to hydroxyl ions. The net result is that the oxygen is consumed and cell pressure doesn't build up.

The separator material used in the cells can absorb about 10 times its own weight in electrolyte and retains some 95% of this when subjected to 25g accelerations for two-minute intervals. The non-woven nylon separator was also shown not to shrink when subjected to internal cell environment tests.

• **Life cycling test**—Gulton engineers are basing their extrapolations of battery life and reliability on an extensive series of life cycling tests which are continually in progress at the Metuchen plant. These tests are being run under three temperature conditions: 48°F, 77°F, and 120°F—and are based on 100-minute orbital cycles which include 35 minutes' discharge and 65 minutes' charge.

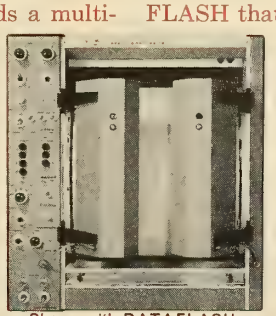
A series run at 36% depth of discharge at 48°F showed a minimum mean life of about 5500 cycles—just over 1 year. At 77°F this figure jumped to in excess of 15,000 cycles, or about 3 years. At the higher temperature, tests showed a mean life of about 1100 cycles. Tests run at much shallower discharge depths indicated an operational life expectancy of several times these figures.

In addition to the nickel-cadmium battery development going on at Gulton, the firm has also developed and produced about 100 prototype models of a 7 amp-hr. silver-cadmium battery which is being evaluated by NASA, the Signal Corps, Boeing, and The Johns Hopkins Applied Physics Laboratory. Though Gulton scientists indicate the silver-cad cell still needs some work, particularly in the development of the separator material, they expect this type of cell, with its higher specific energy of about 25 watt-hours per pound, to find considerable usage. ⌗



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Circle No. 10 on Subscriber Service Card

How Seaslug's Design Was Evolved

by Bernard Poirier

BRITAIN'S Seaslug Mk. 1, one of Europe's first operational ship-launched antiaircraft missiles, recently became the first European system to have its design evolution revealed.

The history of the weapon, representing a number of "firsts" in British government-industry cooperation, was traced by C. Bayly and A. Lightbody, of Whitworth Gloster Aircraft Ltd., in a lecture before the Royal Aeronautical Society.

Development of the medium-range missile (a second, more flexible version of *Seaslug* has been authorized for development) began in 1948. Its first flight test, using four solid boosters, took place in 1951. A great deal of basic and applied research was conducted in government laboratories before the system was committed to industry.

This transfer in itself was unprecedented in Britain. Early design work was performed by Guided Projectile Establishment (now R.P.E., Wescott). Later, Sir W. G. Armstrong Whitworth was appointed design coordinator for a team including General Electric Co., Ltd., and Sperry Gyroscope Co., Ltd.

Various types of guidance systems were considered during the study phases, among them mid-course beam riding plus terminal homing. Line-of-sight beam riding was finally adopted, mainly because it fitted well with the radar environment planned for the ships. It made use of the 901 type radar designed for the wartime Ministry of Supply project known as *LOP/GAP*, an all-liquid antiaircraft missile proposal.

At that time it involved the least complicated missile equipment. Beam riding, it was decided, had inherently good performance against jamming, since the guidance aerial is directed toward the launching vessel and the receiver works on a direct signal from the vessel's radar.

It was soon decided to use solid-propellant booster rockets, since there existed at that time considerable know-how on fast-burning grains used in motors of this type. This, however, was not true of the slow-burning propellants required for the sustainer—in fact, there was then no experience in Britain on any large solid sustainer.

For this reason, a bi-propellant liquid sustainer was selected, with nitric acid as the oxidant and kerosene as the fuel. This combination was ultimately judged the most adequate for naval applications of the choices available. The bi-fuel rocket motor was actually specified in the original service requirement.



FIRST PHOTO released of Britain's Seaslug antiaircraft missile being launched from new Royal Navy guided missile destroyer Devonshire in weapon trials off coast of Scotland.

• **Early tests** — *Seaslug*, like most first-generation missiles, was developed through a series of test vehicles of which the first was a *S.T.V.*—separation test vehicle. The main purpose of the *S.T.V. 1* was to prove the wrapped-round type of boosted configuration and its separation mechanism. A second purpose was to obtain missile aerodynamic data.

S.T.V. 1 made use of eight *Demon* rocket motors arranged in four pairs and designed by R.P.D., Westcott. Four large solid boosters were not yet available.

The first separation experiment was tied to a reduction of boost thrust, and the drag of the boost assembly caused it to move against stops provided on the rear of the boost attachments. This action withdrew locking pins in the front attachments and allowed four toggles to collapse, freeing the quadrants comprising the front attachments.

A separating force was provided by the lift on the canted boost nose cones, and the boosters then flowered outwards about pivot points on the rear attachments. At an angle of approximately 12° the rear hooks disengaged and the boosters flew off under aerodynamic lift forces.

Later tests, in which a dummy sustainer was carried, determined the behavior of the control system in roll and during programed maneuvers in pitch and yaw.

Concomitant tests using complex installations associated with bi-propellant systems caused considerable propulsion difficulties. This delayed the program.

• **Switch to solid**—By 1955 all development work on a liquid sustainer was ceased and the decision was made to concentrate *Seaslug* development around a solid propellant developed by Imperial Chemical Industries Limited.

In the meantime, shipboard firing experience from the missile test ship H.M.S. Girdle Ness suggested other design changes which, along with the decision on the solid sustainer, determined the basic design of the *Seaslug* missiles used during Acceptance Trials and now in full production for the Royal Navy.

The *Mk. 1 Seaslug* is divided into interchangeable sections from nose to tail. The fuze compartment, located in the nose, is replaceable as a unit on the booster weapon. Next, the safety and arming unit, and the warhead can be replaced by a telemetry unit and equipment during development flight tests.

Trial firings took place in Britain and on Australia's Woomera Rocket Range as well as from the Girdle Ness in Mediterranean trials.

The British Admiralty thought enough of the trials to authorize development of the *Mk. 2 Seaslug* even before *Mk. 1* went operational on County Class guided missile destroyers (M/R June 26, 1961).

The Industry Week

Pioneer Space Course Ends

A pioneer course in space technology at Texas A&M College was completed last week. Conducted by Dr. Edward Wolff of Aero Geo Astro Corp., Alexandria, Va., the course was developed to help meet NASA's need for a continuing flow of young scientists well grounded in satellite design and instrumentation fundamentals (M/R, Feb 12, p. 15). A.G.A. is evaluating results of the four-month course and completing manuscripts for space technology text books to be used in future courses A.G.A. expects to make available to engineering schools throughout the country. The company is also developing sets of laboratory equipment which will be used in support of the courses.

Corporate Division Changes

Fairchild Stratos Corp. formed a Spacecraft Systems Engineering Group at its Long Island facility to analyze and solve problems related to new space missions. . . . *Lockheed Electronics Co., a division of Lockheed Aircraft Corp., formed a Telemetry and Space Communications Dept. responsible for production and marketing of PAM, PCM, and PACM airborne and ground station telemetry systems. It will also develop, produce and market welded electronic circuitry.*

New Industry Facilities

CompuDyne Corp. plans to consolidate all Philadelphia operations in one plant. Initial 150,000-sq.-ft.-facility will be built for later expansion. . . . *Bacon Ultrasonics, Inc., established a facility in Ambler, Pa., to begin production of ultrasonic cleaners for industrial, commercial and medical purposes.* . . . American Concertone, Inc., Culver City, Calif., expanded its plant space by over one-third to meet increased demand for military instrumentation tape recorders. . . . *Linde Co., Div. of Union Carbide, began shipments of liquid hydrogen to West Coast development sites from its new Ontario, Calif., plant. Shipments are being made under a $31-million liquid hydrogen supply contract awarded to Linde in December, 1960, by NASA. The 26-ton-per-day facility is the second built by Linde on the West Coast. The first is at Torrance, Calif.* . . . Hoffman Electronics Corp. will build a million-dollar manufacturing plant in El Monte, Calif. to house part of its Military Products Div. operations. Almost all fabricating operations of the division will be consolidated in the new 105,000-sq.-ft.-plant. . . . *Grumman Aircraft Engineering Corp. plans to build a $5-million Space & Missile Engineering Center as well as a new Research Center. The new facilities are, said a Grumman spokesman, "only part of a long-range program designed to enhance the attractiveness of Grumman as a producer of aerospace systems." Design of the engineering center is being completed and ground has been broken on the first wing of the Research Center.* . . . Navigation Computer Corp. has moved its Western Div. to larger quarters in Glendale, Calif. . . . *NASA advised the Senate Space Committee it plans to spend about $2.3 million for Apollo systems integration and checkout facilities at a North American Aviation-managed AF plant in Downey, Calif. Expenditures would be: $20,000 for site development; $1,699,000 for facilities construction and building modification for systems integration and checkout, bonding and test work, a radiographic work and impact testing; and $573,000 for design and engineering services for these and related items.*

News of Mergers and Acquisitions

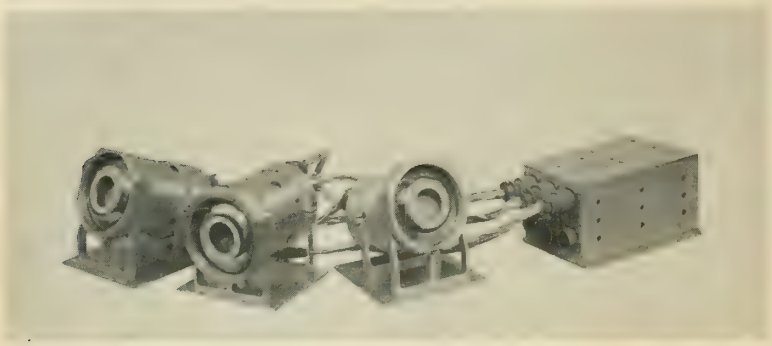
Sprague Electric Co., North Adams, Mass., acquired Sky-Borne Electronics, Santa Fe Springs, Calif., an electronic components manufacturer. S-B will operate as a wholly-owned subsidiary of Sprague. . . . *Conner Spring Manufacturing Co. and Sloss and Brittain, industrial suppliers, will merge. Both companies are based in San Francisco.* . . . Raychem Corp., Redwood City, Calif., entered into an agreement to acquire the Redwood City factory of Anaconda Wire and Cable Co., which will be operated as a wholly-owned subsidiary. . . . *Associated Testing Laboratories, Inc., entered into negotiations to merge with United States Testing Co., Inc. Associated is a major facility for environmental testing of missile, rocket and aircraft components and a manufacturer of environmental test equipment. Merger is subject to stockholder approval.* . . . Brook Labs Co., Inc., and Central Coil Corp. stockholders have approved merger of the two companies. Central manufactures electronic systems for the military, and produces a line of proprietary electronic and electrical products for industry. Brook fabricates sheet, plastic and machine products for precision military and industrial applications.

International News Briefs

International Business Machines Corp. will open a research lab in Japan next year. The basic research lab will employ 30 to 40 Japanese scientists and technicians after some five years. IBM also has a lab in Zurich, Switzerland. . . . *Skinner Precision Industries, Inc., New Britain, Conn., formed a European subsidiary, Skinner (Holland) N.V., to manufacture and market the company's line of solenoid valves for the Common Market and other European outlets.* . . . The Philco Corporation's Lansdale Div. established branches in England and Switzerland to provide sales and marketing services to European transistor, diode, infrared and microelectronics users. . . . *Nuclide Analysis Associates is constructing a mass spectrometer-Knudsen cell system for the University of Rome's Institute of Physical Chemistry and Electrochemistry.*

New Names in The Industry

Codamite Corp. was formed in Anaheim, Calif., to specialize in subminiature digital communications equipment. Present operations will concentrate on production of electronic, keyboard-operated, subminiature code generators. . . . *Cairns Engineering Sales Corp. was formed in Long Beach, Calif., to offer aerospace industry manufacturers direct representation to Federal agencies and prime contractors in Southern California.*



New Product of the Week:

Retarding Potential Analyzer

A RETARDING potential analyzer which measures environmental ion and electron densities and photoelectron emission caused by the extreme ultraviolet radiations in space is available from the Adcole Corp. The system consists of a number of detectors and a program unit, and performs absolute measurement as a function of energy level over a dynamic range of 1.6×10^{-4} with a maximum sensitivity of 10^{-11} amps at full scale.

Each detector contains a cathode and grid assembly and an amplifier. Ions, electrons or extreme ultraviolet radiation strike the cathode and cause a current to flow. This is amplified to provide a signal for telemetry of 0-5 volts. Several amplifiers are available to meet various application requirements.

Circle No. 225 on Subscriber Service Card

Solid-State Commutator

A solid-state commutator that has an offset effect and a drift error of less than 50 microvolts each has been developed by the Advanced Electronics Center of General Electric's Light Military Electronics Department.

Because the transistor pairs used in each gate of the commutator are grown on the same silicon crystal, the probability of the presence of dissimilar materials or impurities in the transistors is reduced. Thus, the transistors maintain equal characteristics over wide temperature ranges.

The commutator operates over a temperature range of from −30°C to 125°C, with linearity variations of under 0.5% for each operating range. The associated drift errors encountered are less than 50 microvolts for the 5-to-10-millivolt full-scale measurement range.

Circle No. 226 on Subscriber Service Card

Portable Power Source

Microwave rf power reaching levels up to 500 watts CW or 2 kilowatts pulse may be obtained with a portable power source Model 218 available from Litton Industries. This self-contained equipment will provide CW, MCW or pulsed power within the frequency ranges from 475 to 725 and 975 to 10,475 megacycles.

In addition to CW power variable from 50 to 500 watts, the power source features pulse capabilities varying from 50 to 2000 watts peak power, 10 to 10,000 microseconds pulse length, and 10 to 10,000 cycles pulse rate. Model 218 has a self-contained magnetron cooling system within the cabinet, as well as interlock circuits.

Circle No. 227 on Subscriber Service Card

Silicon Diodes

MicroSemiconductor Corp. is marketing a line of silicon high-voltage regulator diodes. These single-junction devices with inherent sharp-breakdown, low-noise characteristics make ideal semiconductor tube replacements.

The small solid mass of the device assures reliable operation at mechanical loads tubes cannot attain. The units are primarily used as d-c coupling elements or for other high-voltage, low-current applications in the regulation of high-voltage power supplies. Units will meet or exceed all environmental specifications of MIL-S-19500 and are operable from −65°C to 150°C.

Circle No. 228 on Subscriber Service Card

Wire Cloth

Wire cloth for high-temperature applications up to 2000°F is now available from the Reynolds Divison of National Standard Co. The wire mesh, designated NS-155, is designed for filtering and similar applications in missiles, rockets, space vehicles, electronics and nuclear equipment.

NS-155 alloy has an iron base and nickel, chrome and cobalt as its principal elements—making it resistant to corrosion and oxidation at high temperatures—and can be heat-treated without age hardening.

Circle No. 229 on Subscriber Service Card

UHF/VHF Converter

A UHF/VHF converter, the Model 1405, which will accommodate an unlimited number of receivers to record UHF signals on existing VHF ground equipment, is available from the Instrumentation Division of Microdot Inc. The unit is housed in a weatherproof case, allowing the converter to be mounted adjacent to the receiving antenna with minimized signal loss in the lead-in cable. Contrasted to the noise figures on existing UHF receivers of 10 to 12 db, the Model 1405 registers only 5½ db at mid-frequency.

Without tuning, the Model 1405 converts any signal in the 2200 to 2300 megacycle range for recording in the 215-to-260 megacycle VHF range, thus allowing the conversion required by many new programs without making existing ground receivers obsolete.

Circle No. 230 on Subscriber Service Card

Rotary Solenoid Drive

A rotary solenoid drive designed for remote control of any "Blue Line" switch from 20 to 200 amps, 600 VAC, is available from American Solenoid Co. Inc.

It can be arranged to drive a control switch in single steps, continuous steps, or as a master-slave for completely automatic operation. Dual Manual/Automatic operation can also be supplied. A maximum of 18 positions is available. Life time exceeds 5 million operations.

Circle No. 231 on Subscriber Service Card

Voltage Arrestors

Electro-Neutronics, Inc., has developed a family of transient voltage arrestors and signal input protectors for elimination and/or isolation of voltage transients or over-voltage conditions from systems or electrical equipment.

These units involve the use of new concepts resulting in reliability of better than 99.999%, clamps high-rise transients in less than one (1) microsecond, high current carrying capacity (10,000 A for durations of 0.1 sec.) and automatic reset and restore.

The units can be easily utilized at

any systems input including telephone line and microwave repeaters, utility lines, communications, computer, weapons, control and command systems where minute down-time, manual reset or replacement can no longer be tolerated.

Circle No. 232 on Subscriber Service Card

Voltage Calibrator

A new model RMS Voltage Calibrator for precision source of RMS voltages from 0.5 microvolts to 1.0 volt, when used with an oscillator or signal generator, is available from Instrumentation Division of IRI.

The instrument operates from dc through 250 kc with an output accuracy ±1% in the dc to 10 kc range. Its temperature-compensated thermocouple assures true RMS voltage output regardless of input waveform. Vernier control allows accurate setting of the input signal.

Circle No. 233 on Subscriber Service Card

Test Trays

Delta Design, Inc., has available large-capacity test trays which allow efficient and accurate testing of axial



lead components and transistors over a temperature range of −100°F to +400°F.

The test drawers are well insulated, and all structural members are of stainless steel and aluminum. They are fitted with guides for protection from falling during removal from the chambers.

Circle No. 234 on Subscriber Service Card

Subminiature Connector

Winchester Electronics, Inc., is marketing a Subminiature High Density Connector.

Named the SRD Series, the connector is designed for use with instrumen-



tation employing small modular packages. It is extremely suitable for logic units in computors and allied applications. Only .6-in. square, the connector has center jackscrew for quick and easy engagement and disengagement and is readily adapted for potting.

Circle No. 235 on Subscriber Service Card

High-Pressure Transducer

Production of a pressure transducer providing high-pressure measurements in 50g environment has been announced by Giannini Controls Corp. Specifications include a resolution of 0.25%, hysteresis of 0.5% and repeatability of 0.5%. Ranges extend from 0 to 100 psi to 0 to 8000 psi. It is 1 in. in dia. x 2½ in. long, and weigh 0.312 lb.

Circle No. 236 on Subscriber Service Card

Microminiature Connectors

Microminiature connectors are available from Hermetic Seal Corp. Designated Series MM, these units are designed to operate with high reliability at elevated temperatures and under conditions of high vibration or excessive humidity. They exceed the requirements of MIL-C-8384 and MIL-C-5015 in all applications.

Standard connectors (plugs and receptacles) are furnished with stainless steel polarized guide pins and guide sockets. Standard contacts are 5, 7, 9, 11, 14, 20, 26, 29, 34, or 44. The standard molding compound is glass-filled Diallyl Phthalate, Type GDI-30, (color green) which exceeds MIL-M-19533 requirements.

Circle No. 237 on Subscriber Service Card

Acceleration Switch

A new latching-type subminiature acceleration switch with manual reset has been developed by Humphrey, Inc. The AS40 is rugged enough to withstand the vibration specified by MIL-E-5400.

The unit is a positive latching type rated at 15 amps, 28 volts dc. Once it has operated, it remains latched until manually re-set. A visual red or green color indication shows whether the switch is in the open or closed position. The switch is normally open and closes upon acceleration above the pre-set value. It is available in ranges from 5G to 100G.

Circle No. 238 on Subscriber Service Card

new literature

DEEP-DRAWN PACKAGING—Packaging Pointers, a four-page leaflet, describes the benefits of deep-drawn aluminum containers for packaging electronic and missile components. Topics covered include reliability in meeting MIL specifications, industrial design and esthetic advantages, customizing/accessorizing, and tooling.

Circle No. 200 on Subscriber Service Card

DRY-REED SWITCH CATALOG—Hamlin, Inc. announces a dry-reed switch operating in pressurized pure hydrogen atmosphere which can be utilized where the requirements are for a double-throw switch with less contact bounce on *both* electrodes and with a contact arrangement FORM C (Polarized). The polarization characteristic of this switch allows an electromagnetic coil to actuate the reed in *either* direction, as determined by the polarity of the coil with reference to the polarity of the fixed contacts. Polarization of fixed contacts is normally accomplished with enternal permanent magnets.

Circle No. 201 on Subscriber Service Card

SPECIFICATION OF TUBING — A practical guide for the specification of small-diameter tubing for cold forming is offered in a four-page article reprinted by Superior Tube Co. The article describes eight tests—four mechanical and four manipulative—to furnish the information that users require to specify tubing that will not crack or split during cold-forming. The mechanical tests measure tensile strength and hardness, yield strength, elongation of ductility, and work-hardening, and tell how much a tube can be cold-drawn before it work-hardens to the point where annealing is required for further drawing. Also listed are properties of 29 typical tubing materials in the annealed conditions.

Circle No. 202 on Subscriber Service Card

DYNAMOMETER—John Chatillon & Sons have prepared a four-page illustrated brochure describing in detail the operating characteristics and features of their 1000 series. These instruments have specially designed hysteresis brakes for improved high-speed performance and low starting torque. The model 1200 has automatic transfer of torque ranges through a progressive spring loading system, and is suitable for research and manufacture involving torque measurement of electric, hydraulic or air motors, turbines, rotary spring activators, etc.

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contracts

AIR FORCE

$16,836,000—**Boeing Co.**, Seattle, for work on *Minuteman* ICBM's.

$16,750,000—**General Electric Co.**, Missile & Space Vehicle Dept., Philadelphia, for nose cones for *Titan II* ICBM's.

$10,309,000—**General Motors Corp.**, for an inertial guidance system for space exploration. Work to be done at Milwaukee.

$10,203,000—**Martin Marietta Corp.**, Baltimore, for work on *Titan* ICBM bases in the West.

$8,100,000—**Avco Corp., Lycoming Div.**, Stratford, Conn., for production of operational Mark 5 re-entry vehicles for *Minuteman* missile.

$7,703,752—**Boeing Co.**, Seattle, for equipment for the *Minuteman* program (supplemental contract).

$7,344,060—**American Air Filter Co.**, for controls for *Minuteman* missile. Work to be done at St. Louis.

$7,205,000—**Radio Corp. of America**, New York, for continued operation and maintenance of Ballistic Missile Early Warning System facilities at Thule, Greenland, Clear, Alaska, and Riverton, N.J.

$6,807,365—**General Electric Co.**, for design and development in Philadelphia of a target vehicle for *Nike-Zeus* antimissile missiles.

$6,300,000—**Thiokol Chemical Corp.**, Bristol, Conn., for *Minuteman* Stage 1 solid-propellant rocket motors and related equipment.

$5,504,009—**Marquardt Corp.**, for design, building and installing a modification kit for electronic equipment. Work to be done at Pomona, Calif.

$4,363,996—**North American Aviation, Inc.**, Los Angeles, for work on *Atlas* missile propulsion systems (supplemental contract). Work to be done at Canoga Park, Calif. and Neosho, Mo.

$3,163,299—**North American Aviation, Inc.**, Downey, Calif., for work on *Minuteman* missiles (2 contracts).

$2,800,000—**Radio Corp. of America**, for producing a prototype subsystem for detecting and tracking earth satellites. Work to be done at Burlington, Mass.

$2,800,000—**Marquardt Corp.**, Van Nuys, Calif., for advanced research on hypersonic ramjets and heat exchangers.

$2,600,000—**Lockheed Aircraft Corp.**, Sunnyvale, Calif., for two space vehicles (2 contracts).

$2,430,219—**Martin Marietta Corp.**, Baltimore for continued research on the *Titan II* missile weapons system (supplemental contract).

$1,964,682—**North American Aviation, Inc.**, Los Angeles, for research and development (supplemental contract). Work to be done at Downey.

$1,807,365—**General Electric Co.**, New York, for the design and development of a *Nike-Zeus* target vehicle (supplemental contract). Work to be done at Philadelphia.

$1,580,000—**Lockheed Aircraft Corp.**, Burbank, for space satellite systems (supplemental contract).

$1,500,000—**General Precision, Inc.**, Little Falls, N.J., for work on a stellar inertial guidance system for space exploration.

$1,481,000—**Avco Corp.**, New York, for production of a re-entry vehicle. Work to be done at Stratford, Conn.

$1,387,655—**General Dynamics Corp.**, for missile sites communications equipment. Work to be done at Rochester, N.Y.

$1,200,000—**Lockheed Aircraft Corp.**, Burbank, for production of a space satellite vehicle. Work to be done at Sunnyvale, Calif.

$1,198,617—**North American Aviation, Inc.**, Los Angeles, for provision of spares for the *Minuteman* missile guidance and control system (supplemental contract). Work to be done at Downey.

$1,151,000—**Aerojet-General Corp.**, for *Titan* missile componenets. Work to be done at Sacramento.

NAVY

$4,691,652—**General Electric Co.**, for guidance control sections for the *Sidewinder* air-to-air missiles. Work to be done at Utica, N.Y.

$3,346,276—**General Electric Co.**, Syracuse, N.Y., for repair parts for *Nike-Hercules*.

$3,176,512—**Sanders Associates, Inc.**, Nashua, N.H., for classified electronics equipment.

$1,768,692—**General Electric Co.**, Pittsfield, Mass., for modification kits for fire control systems for the *Polaris* missile.

$1,721,230—**Hughes Aircraft Co.**, Los Angeles, for classified electronics equipment.

$1,678,692—**General Electric Co.**, Pittsfield, Mass., for modification kits for *Polaris* missile.

$1,049,327—**General Electric Co.**, Pittsfield, Mass., for portable guidance test equipment for the *Polaris* missile program.

$495,000—**United Aircraft Corp., Norden Div.**, Norwalk, Conn., for gas pressure systems used in advanced *Tartar* and *Terrier* missiles.

$301,713—**Electrospace Corp.**, Glen Cove, N.Y., for Radiac Detectors.

ARMY

$5,500,000—**General Electric Co.**, Syracuse, for *Nike-Hercules* repair parts.

$2,000,000—**Burroughs Corp.**, Detroit, for classified work.

$1,194,906—**Ling-Temco-Vought**, Dallas, for production of launchers for the *Sergeant* missile system.

$500,000—**Hughes Aircraft Co.**, Culver City, Calif., for development of a lightweight portable antitank missile.

NASA

$300,000—**Space-General Corp.**, El Monte, Calif., for development of an inflatable paraglider.

INDUSTRY

$200,000—**AiResearch Manufacturing Co.**, Phoenix, from **North American Aviation, Inc.**, for development of power conversion components and technology in support of the *SNAP* Nuclear Space Power Program.

$125,000—**McCormick Selph Associates**, Hollister, Calif., from **Martin Co.**, Orlando, for exploding bridgewire for the Army's *Pershing* missile.

Bissett-Berman Corp., Santa Monica, from **North American Aviation's space and information div.**, Downey, Calif., for a portion of the *Apollo* spacecraft's information systems (undisclosed amount).

Associated Testing Laboratories, Inc., Wayne, N.J., from **Electro-Mechanical Research, Inc.**, Sarasota, Fla., for testing components of the *Dyna-Soar* space glider program (undisclosed amount).

Bolt Beranek and Newman, Inc., Los Angeles, from **Aerospace Corp.**, for consulting services on the acoustic vibration environment of the *Titan III* vehicle (undisclosed amount).

Marquardt Corp., Van Nuys, from **Aerojet-General**, Sacramento, for first-stage nozzles for the third generation of *Polaris* missiles (undisclosed amount).

Circle No. 11 on Subscriber Service Card

—reviews—

001 QUESTIONS ANSWERED ABOUT SPACE, Clarke Newlon. Dodd Mead & Co., New York, 137 pp., $6.

A compilation of Space Age data, ranging from The History of Space Exploration, through Space and The Future, written in a simple, popularized, question-and-answer style. Unfortunately, probably due to space limitations, many of the answers are over-simplified. Nevertheless, the book, written by a former executive editor of M/R, is a good basic primer on the space field. In addition to the historical aspects, major topics covered include techniques of space exploration, power sources, launch vehicles, space systems, human factors, space law, research, and biographies of industry and military leaders.

D.N.

BASIC PHYSICS OF THE SOLAR SYSTEM, V. M. Blanco and S. W. McCuskey, Addison-Wesley Publishing Co., Inc., Reading, Mass., 307 pp. plus fold-out lunar map, $7.50.

This book is a well-fashioned link between texts giving purely descriptive astronomy and those designed for students of celestial mechanics. The authors work from basic principles in deriving their equations, and include sufficient text to illustrate and explain them. The book can be understood by readers with two years of college mathematics and physics.

Chapter contents: astronomical coordinate systems, planets and their satellites, Earth-Moon system, celestial dynamics and the two-body problem, celestial dynamics and the three- and *n*-body problem, sun and interplanetary space, and a number of astronomical tables.

DISCRETE VARIABLE METHODS IN ORDINARY DIFFERENTIAL EQUATIONS, Peter Henrici, John Wiley & Sons, Inc., New York, New York, 407 pp., $11.50.

A technical text for mathematicians and mathematically inclined engineers and physicists, this work grew out of the author's lecture notes for a course he gave on the senior level entitled: "Numerical Methods in Differential Equations." Considerably expanded from these notes, the present book contains some of the author's original contributions to numerical analysis—particularly in the field of error propagation.

Contents: one-step methods for initial value problems, multistep methods for initial value problems, and boundary value problems.

RECENT DEVELOPMENTS IN GENERAL RELATIVITY, L. Natanson et al, Pergamon Press, Inc., New York. 500 pp., $12.50.

Part I consists of seven articles reviewing the present status of problems involved in gravitational radiation, motion, experimental testing, quantization, unified theories and cosmology, as well as mathematical problems of general relativity.

Part II has 38 original papers representing current schools or thought and mathematical methods and approaches to the study of relativity.

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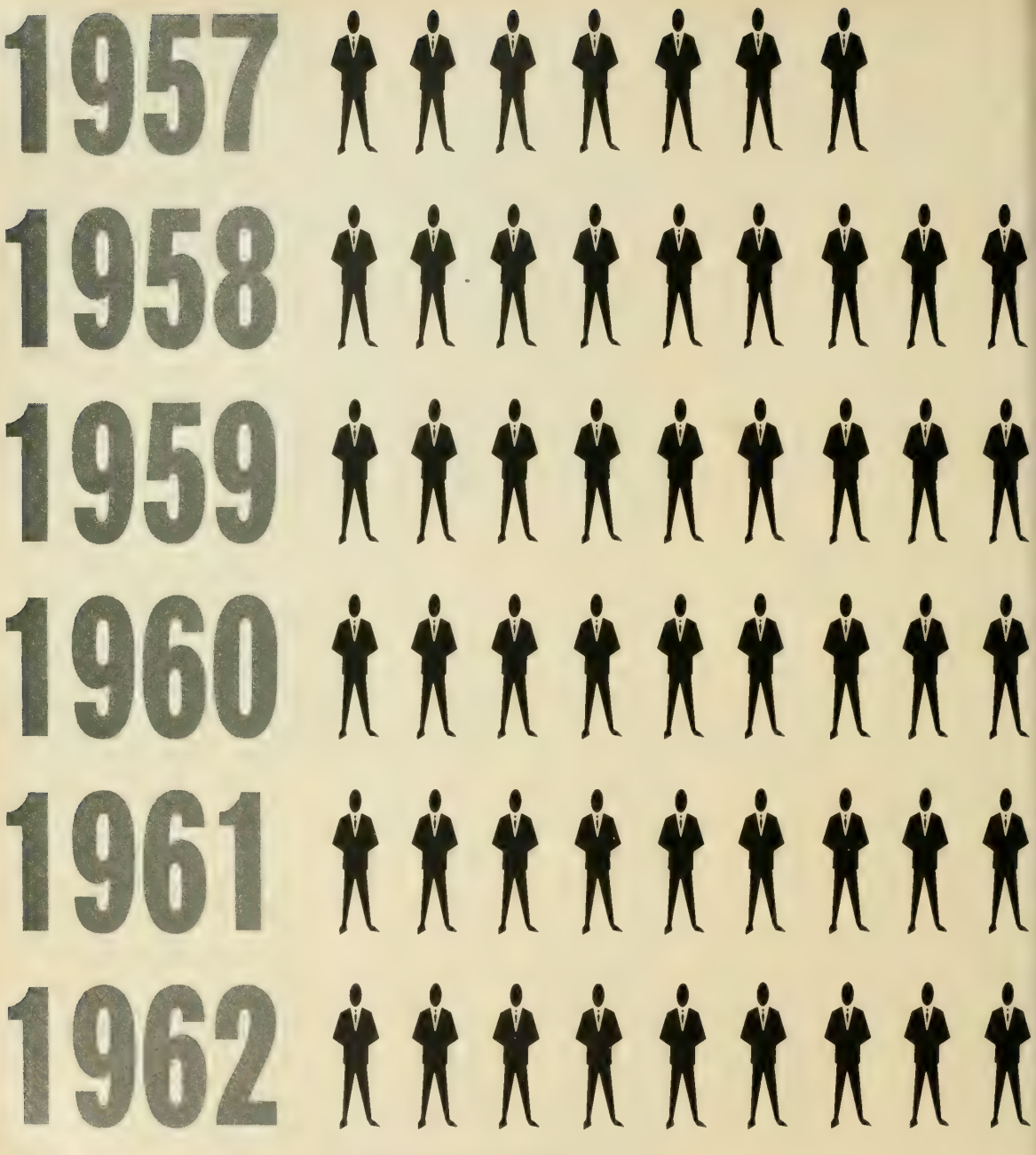


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Scientists who have done supersonic aerodynamic research.
Scientists experienced in working with information and sensing systems, platforms, infrared, sensors, flight controls, airborne computing and data handling systems.
Engineers familiar with programming, operations, and instrumentation for ballistic missile flight test.
Reliability Engineers to assess the reliability and to optimize the configurations and mission profiles of space systems.
Chemical Engineers to work on the development and applications of structural adhesives for aerospace vehicles.
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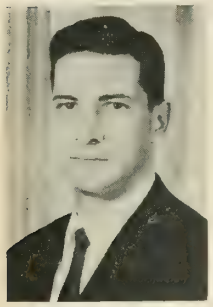
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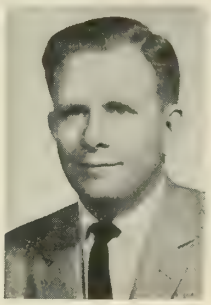
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names in the news



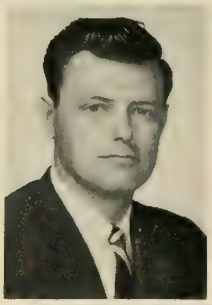
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Charles F. Horne: President of General Dynamics/Pomona and General Dynamics/Electronics, Rochester, N.Y., and senior vice president of General Dynamics, New York, elected president of the Electronic Industries Association.

Dr. J. A. Jamieson: Named manager of research in Aerojet-General Corporation's Astrionics Division, Azusa, Calif.

Dr. William R. Jewell: Named director of White Sands Missile Range's electromechanical laboratories, White Sands, N. M.

Jack F. Shearer: Elected vice president of the Pyle-National Co., Chicago.

Jerome D. Kennedy: Appointed president of Applied Dynamics, Inc., Ann Arbor, Mich.

William H. Morgan: Appointed manager of Milgo Electronic Corp.'s West Coast office, Northridge, Calif.

William G. Vorhaus, Jr.: Appointed contract administration manager of Wyle Laboratories, El Segundo, Calif.

Robert A. Arrison, Jr.: Appointed director of engineering of Vacuum-Electronics Corp., Plainview, N.Y.

Robert C. Bartz: Appointed director of material at Republic Aviation Corp., Farmingdale, L.I., N.Y.

E. L. McCarty: Appointed a vice president and director of Rocker Industries, Inc., Wilmington, Calif.

Donald M. Stuart: Vice president and general manager of Hazeltine Technical Development Center, Inc., Little Neck, N.Y., received the 1962 Pioneer Award of the Professional Group on Aerospace and Navigational Electronics of the Institute of Radio Engineers (IRE).

Harry E. Morgan: Appointed vice president of the Ender-Monarch div. of Acoustica Associates, Inc., Los Angeles.

Charles C. Davis: Elected vice president of Alco Products, Inc., New York City.

Dr. Samuel Koslov: Appointed chief, physical sciences, by Allied Research Associates, Inc., Boston. **Leonard J. Corti** appointed vice president.

Dr. Carl E. Faflick: Appointed director of the advanced system planning organization of Sylvania Electronic Systems, Waltham, Mass.

Ralph W. Rawson: Elected vice president and general manager of the chemical and metallurgical division of Fansteel Metallurgical Corp., North Chicago.

Eugene A. Solomon: Appointed works manager of the General Instrument Corp., capacitor division, Tazewell, Va.

Rocco Tamburello: Named manager of quality control for Cohu Electronics, Inc., Kin Tel Div., San Diego.

Richard B. Foster: Appointed general manager of Minneapolis-Honeywell's Boston division, succeeding **Melvin P. Fedders,** who has been named to the newly created position of manager of operations for the company's St. Petersburg, Fla., facility.

Dr. Roy Smelt: Appointed vice president and general manager of Lockheed Missiles & Space Co.'s new Nuclear Space Program Division, Sunnyvale, Calif.

Dr. Donald A. Guthrie: Named executive assistant to the manager of central research at Lord Manufacturing Co., Erie, Pa.

Dr. Eugene H. Klingler: Appointed chief engineer for the special application recorders and instrumentation dept. of the special products division of Fairchild Camera and Instrument Corp., Los Angeles. **A. C. Plautz** appointed manager of engineering administration.

Donnell Rhody: Promoted to director, project planning, for the aircraft-missiles division of Fairchild Stratos, Hagerstown, Md.

Bruce U. Glass: Promoted to vice president-general manager of Instrument Corp. of Florida, Melbourne, Fla. **Duane C. Brown** promoted to vice president, research and analysis.

Richard W. Larrick: Director of public relations for United Technology Corp., Sunnyvale, Calif., named recipient of 1962 public relations trophy given by the Aviation/Space Writers Assn.

Thomas J. Vincent: Promoted to director, corporate programing office, Fairchild Stratos, Hagerstown, Md.

William G. McMurry: Appointed value control manager with Motorola Inc.'s military electronics division, Scottsdale, Ariz.

Bill Strunk: Elected a vice president of Astro-Systems, Inc., El Monte, Calif.

Robert M. Brunson: Appointed vice president of General Precision's Librascope Div., Glendale, Calif.

Lt. Col. Lionel Sarrasin (ret.): Appointed general sales manager, Schaevitz Engineering, Pennsauken, N.J.

Martin H. Greenwald: Promoted to assistant chief-radar and communications in the engineering department of Norden Div. of United Aircraft Corp., Norwalk, Conn.

Robert M. Mitori: Named senior staff engineer at Rixon Electronics, Inc., Silver Spring, Md.

Edward M. Hoey: Appointed vice president of Hektor Scientific Co., Foxboro, Mass.

Francis M. Hope: Named manager of the ground support engineering division of Dalmo Victor Co., Belmont, Calif.

Allen V. Butterworth: Appointed head of the evaluation studies department of General Motors Defense Research Laboratories, Santa Barbara, Calif.

Harry R. Smith: Appointed assistant to the president of Ets-Hokin and Galvan, Inc., San Francisco.

H. Douglas Lowrey: Named president of Chrysler Corp.'s space division, New Orleans.

Carl H. Johnson, Jr.: Appointed manager of American Air Filter Co.'s Minneapolis branch office.

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when and where

JUNE

Society of Automotive Engineers, Inc., summer meeting, Chalfonte-Haddon Hall, Atlantic City, N.J., June 11-15.

Molecular Beams Conference, Brookhaven National Laboratory, Upton, N.Y., June 11-13.

Cornell University Seminars in Industrial Engineering Operations Research and Statistics, Ithaca, N.Y., June 12-15.

Armed Force Communications and Electronics Association, Annual Convention and Show, Sheraton Park and Shoreham Hotels, Washington, D.C., June 12-14.

National Society of Professional Engineers, Annual Meeting, Sheraton-French Lick Hotel, French Lick, Ind., June 13-16.

American Institute of Electrical Engineers, Summer General Meeting and Aerospace Transportation Meeting, Denver Hilton Hotel, Denver, June 17-22.

American Nuclear Society, Annual Meeting, Statler Hilton Hotel, Boston, June 18-20.

Technical Writing Conference, University of Michigan, Ann Arbor, June 18-22.

Institute of the Aerospace Sciences, Annual Meeting, Los Angeles, June 19-22.

American Society for Testing and Materials, Annual Meeting, Statler Hotel, New York City, June 24-29.

Sixth National Convention on Military Electronics, Shoreham Hotel, Washington, D.C., June 25-27.

Progress Report to the Military Electronics Industry Professional Group on Military Electronics, IRE, Shoreham Hotel, Washington, D.C., June 25-27.

Summer Institute in Dynamical Astronomy, Yale University, New Haven, Conn., June 25-August 2.

ASME Aviation and Space Division Annual Conference, University of Maryland, College Park, June 26-28.

Third International Symposium on Rarified Gas Dynamics, sponsored by AFOSR, Directorate of Engineering Sciences, ONR, NASA, University of Paris, France, June 26-29.

JULY

Reliability Training Conference, sponsored by American Society for Quality Control, Princeton Inn, Milwaukee, July 8-15.

Technical Report Writing for Engineers and Scientists, UCLA, Los Angeles, July 16-20.

American Rocket Society, Lunar Missions Meeting, Pick-Carter and Statler Hilton Hotel, Cleveland, July 17-19.

AUGUST

Institute of the Aerospace Sciences, Man-Machine Competition, Olympic Hotel, Seattle, August 10-11.

Society of Automotive Engineers, National West Coast Meeting, Biltmore Hotel, Los Angeles, August 13-16.

Nuclear Propulsion Conference, sponsored by the American Rocket Society, American Nuclear Society, and Institute of Aerospace Sciences, U.S. Naval Post Graduate School, Monterey, Calif., August 15-17.

The Ninth International Symposium on Combustion, Cornell University, Ithaca, N.Y., Aug. 27-Sept. 1.

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Innovation in Research Contracts

LAST FALL, Dr. Simon Ramo, executive vice president of Thompson Ramo Wooldridge, pointed out in a speech that we are still trying to operate today with a government-industry contracting relationship designed for an entirely different combination of circumstances.

One of the bigger problems facing the National Aeronautics and Space Administration and the Department of Defense has been to adjust past methods of doing business to the fast-whizzing technology of the Space Age.

Too often, the orbital speed of our satellites has been hitched to contracting or development procedures more suitable to the design, manufacture and procurement of blankets for the horse cavalry.

It is a pleasure, therefore, to find the government sponsoring an innovation in long-established contracting procedures. The most recent example of this is the new policy of the Air Force Office of Scientific Research in funding long-term basic research contracts with industry.

Dr. Knox Millsaps, AFOSR executive director, goes so far as to call it a breakthrough in industrial research contracting.

The procedure in the past has been to finance industry research contracts on a year-to-year basis, a situation which leaves the industry scientist with considerably less peace of mind than his university brethren. True, he generally is compensated for this insecurity with a somewhat larger paycheck. That is little comfort, however, if the ups and downs of government financing leave his company without a contract for his services the next year.

It also does not give him much confidence that the research he is conducting will be carried to fruition.

AFOSR has brought about a major change in this situation. This past week, it has announced the opening of negotiations with Westinghouse Electric, IBM and RCA for three years of advanced funding on basic research proposals in the solid-state field.

These will be on the usual cooperative basis, with AFOSR and the companies each providing about half the funds on projects that range to almost half a million dollars in size. Future contracts of this type can be expected.

Research like this in the past has been funded yearly on what might be called a segmented basis—or less generously, an uncertain basis. Now, for the first time, it is being financed on a unit basis for a completed job of research. The particular work involved is concerned with obtaining single crystals of adequate purity and controlled properties. This has been one of the bottlenecks in development of solid-state devices.

One of the major effects will be to give the scientist working in industry the same job security as the university scientist. He can go about his work confident that his job will not be cut off a year or 18 months from now by a military whim.

The new system also has other advantages for industry.

It provides industrial firms with a continuous and competent guidance from AFOSR scientists into basic research problems that are of pertinent military interest. It gives them some assurance of follow-on military interest in any applied research and development which may arise from the basic research. It also gives industry a carrot other than money with which to attract highly qualified scientists interested in working on the research frontiers.

These men are as needed in industry as they are in universities.

Attractiveness of this new type of contract is evidenced by the willingness of the three firms to share the financing. Dr. Millsaps lauds this as an outstanding example of far-sightedness on the part of industry.

It also is a fine example of government managers developing new methods to improve the government-industry partnership. It is particularly laudable that the Office of Aerospace Research is taking the lead in this.

OAR, of which AFOSR is a part, has the responsibility for managing the Air Force basic research program, as well as that part of the applied research program which is assigned to it. Its establishment over a year ago as a separate command directly responsible to Headquarters, USAF, marked a recognition of the need for improvement in basic research procedures.

IT IS GRATIFYING, therefore, to see OAR fulfilling its assignment so conscientiously. Dr. Millsaps, who is OAR chief scientist as well as AFOSR executive director, says the intent of the new contracting approach is to find a way of "doing it better."

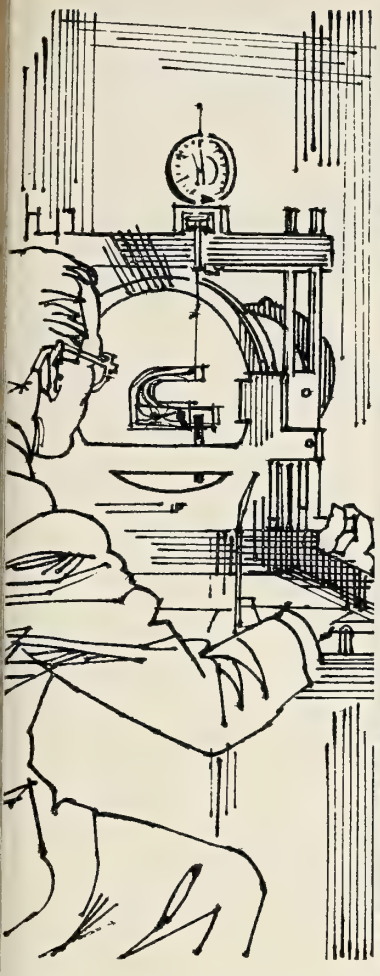
To find this awareness in a basic research group that there is a need for "doing it better" in contracting is refreshing. We are certain the industry will greet the innovation with enthusiasm.

While there is not expected to be any significant growth in the minor portion of its funds going to industry, the new contracting approach could lead to a small step-up in spending of AFOSR funds with industry. If so, this would be a welcome development. Basic research frequently leads to applied results more quickly in an industrial than in an academic atmosphere.

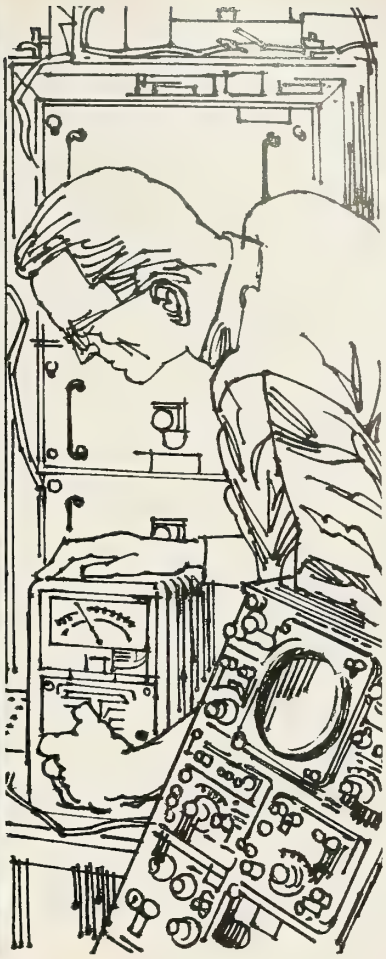
As the late industrialist Charles F. Kettering said, "Research is something that if you don't do it till you have to, it's too late."

AFOSR has made a significant contribution toward assuring that we are not too late.

William J. Coughlin







Saturn openings at Boeing for Engineers and Scientists

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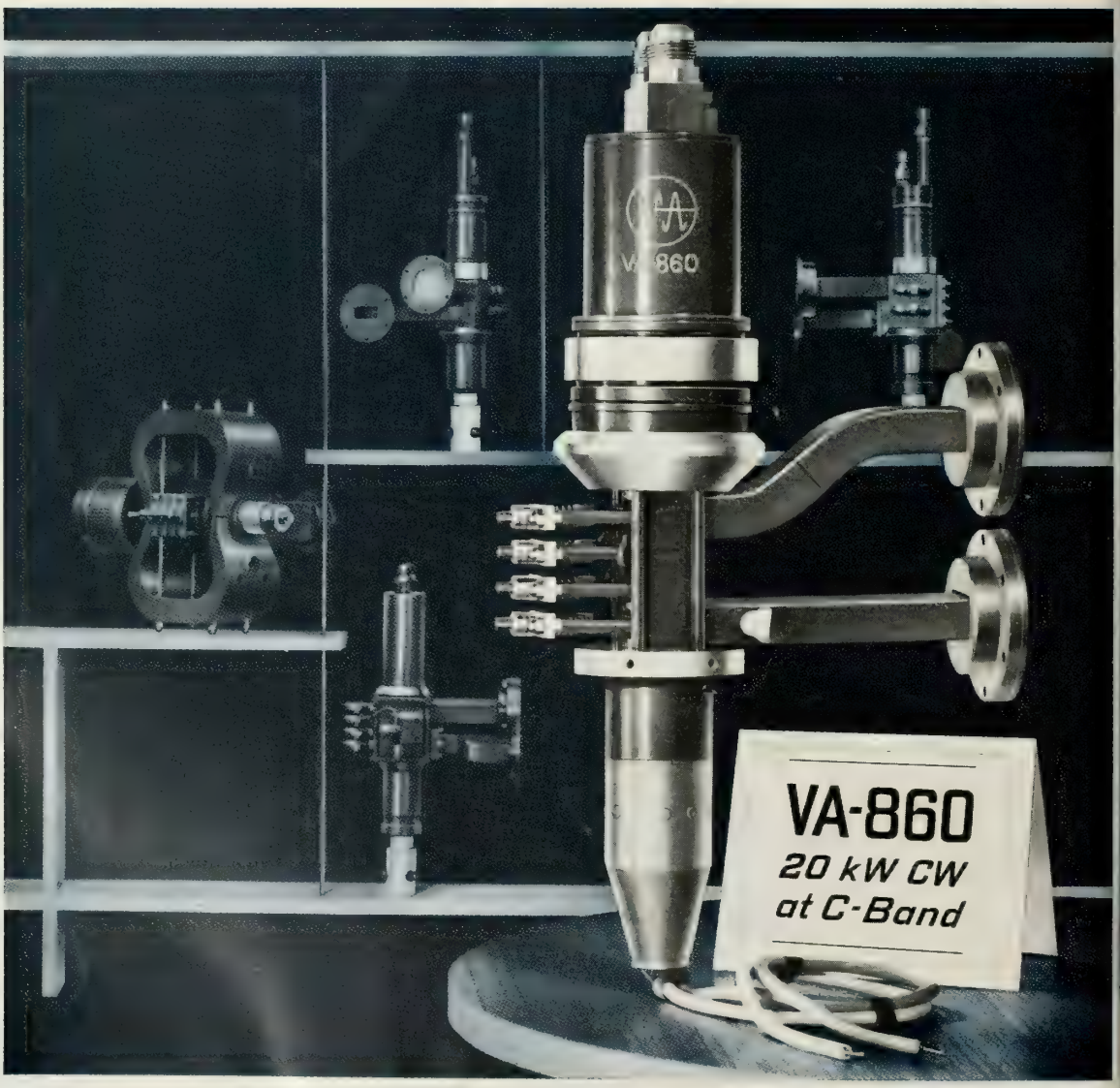
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E WEEKLY OF SPACE SYSTEMS ENGINEERING

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Army's Ryan 124-E Jet Target Drone

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SPECIAL REPORT

U.S. Presses Plans for Man on Moo



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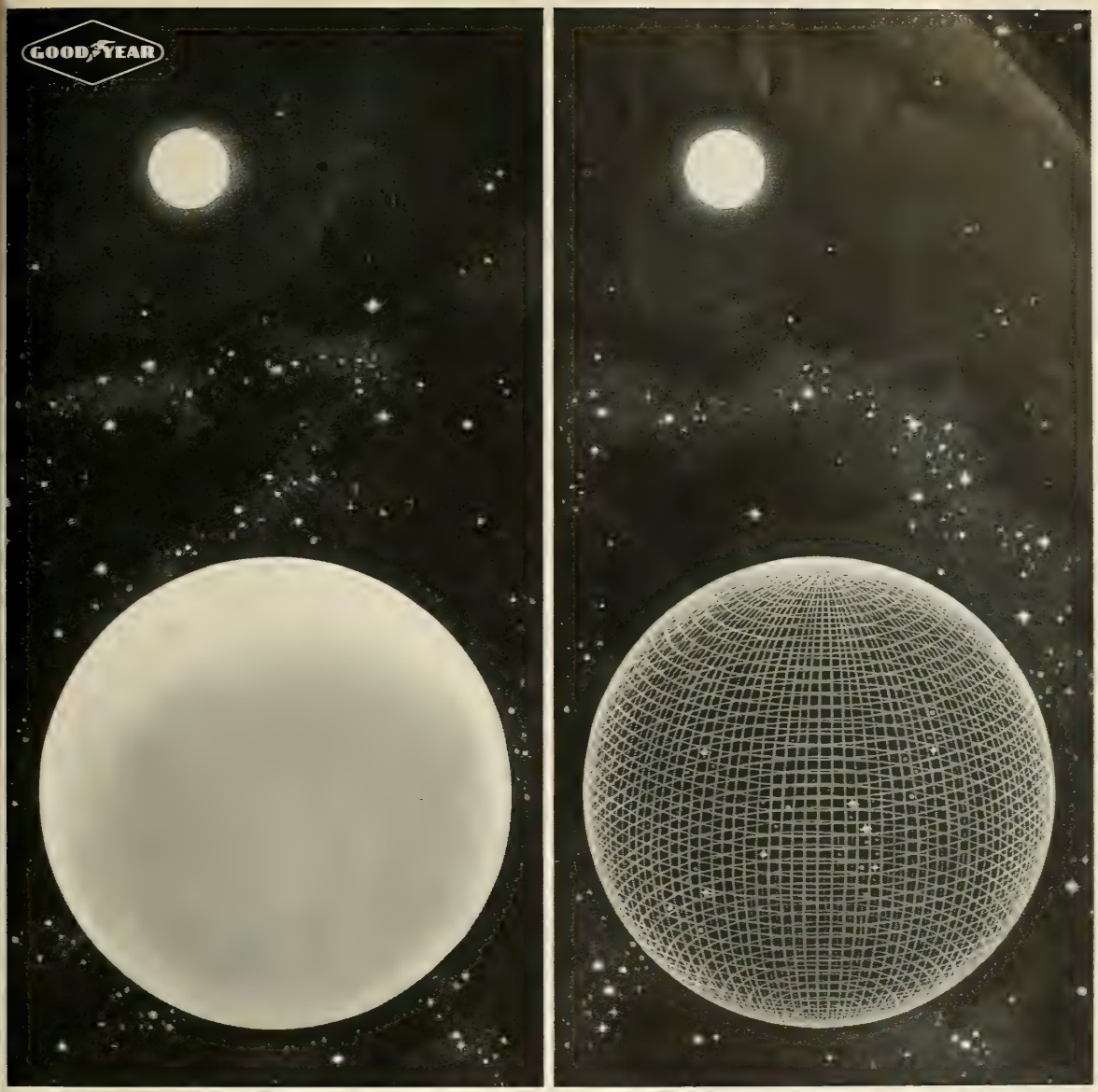
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missiles and rockets

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THE COVER

Army's Ryan 124-E Firebee jet target recently set record for this type of free-flying drone by flying for 112 minutes, exceeding 61,000 ft. altitude. 124-E is advanced version of Q-2C Firebee used by Navy and AF.



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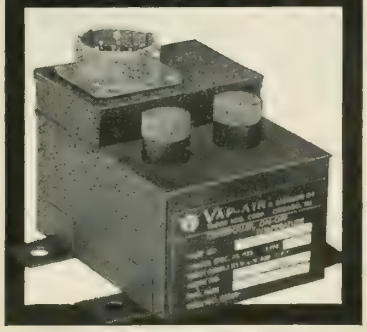
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letters

Titov's Boomerang

To the Editor:

Congratulations on your editorial, "Go Home, Russian" (M/R, May 14).

This was of particular—and delightful—interest to me, since I had recently completed the first-person book "I Am Eagle!" with Titov. The amount of information he released in his appearances in the United States was incredibly low—and it is astonishing that Titov acted in this manner, when he has previously seen fit to release so much more information, and in great detail as well.

There is no question—as you pointed out—but that Titov did not appear in the United States so much as a cosmonaut, but as a beautifully-trained representative of the USSR. Unfortunately—for the USSR—his glib performance tended to boomerang. I watched and listened with great care to the questions that Glenn put before Titov; there was absolutely no question of the nature of the queries—and Titov, despite his having answered those same questions during interviews in the USSR, pointedly and unabashedly refused to hew to the subject, and instead went off on his propagandizing gambits. That Titov was instructed, and forcefully, to avoid absolutely any discussion on certain points is obvious. The USSR has released its failures with *Spacecrafts I* and *III;* Gagarin has talked of radio equipment failure in his countdown; Khrushchev has revealed necessary replacement of a booster rocket for *Lunik II* . . . all these are publicly released facts, yet Titov shied away from even this material, providing additional proof of his instructions to adhere only to party orders.

In this respect his appearance here was one of shabbiness, and a discredit not only to the relationships of the two countries, but an insult to the very real capabilities of those still-unidentified hardware scientists who made it all possible. Titov did far more harm through his glibness than he did good—for which I say Amen.

Martin Caidin
Plainview, N.Y.

Dividing the Blame

To the Editor:

The treatment of Scott Carpenter by the press following his orbital flight leaves me with a bad case of indigestion.

We have had four men in space, and already the PILOT ERROR boys are getting their claws hooked in.

Those of us who have been in the flying business for many years have been wondering just how long you were going to let this dedicated group of pioneers alone so that they could do their job without the tremendous pressure of adverse public and non-flying associates' criticism of their abilities. I can see that time has finally run out—the vultures have drawn themselves to the party.

Having been in this business since sometime before World War II, I feel that I can now be classed with the old timers. And having spent some 15,000+ hours wandering around the world in about every piece of heavy flying equipment built, I think I can speak with some authority concerning the *pressures* that are heaped upon crew members by their ground-pounding brethren and in some instances by their peculiar breed of fellow pilot who has drifted away from the job of line flying and now enjoys sitting in judgment from behind a typewriter or official judge's desk.

I take note particularly of the words, "pilot error," which you have taken pains to place in quotation marks in your June 4 report on the flight of *Aurora-7*. Since your correspondent has done nothing to indicate any defense of Mr. Carpenter, we can only assume that his attitude is that he is only reporting and is not interested in the fact that by making no defense, he is actually making an accusation that Mr. Carpenter was grossly inadequate.

Isn't it strange that newsmen make so much of Mr. Carpenter's not doing his job, but fail to make the tone and texture of their articles demand the heads of the scientists, engineers or production people who have failed to produce equipment that will not booby trap a crew member?

May I point out the paragraph in your story stating that Mr. Carpenter had to be "repeatedly warned" about overuse of manual control system? This one is a Jim Dandy . . . I wonder why your writer didn't land on the backs of the scientists, engineers and production folk and list *by name* those responsible for the improper functioning of his automatic systems. I don't see any reference to Dr. Joe Doaks, junior scientist, who passed a course in heat transfer but failed to design a fail-proof system. It is interesting that Mr. Carpenter "failed to copy sunset and sunrise times," but the writer says nothing about the failure to provide for possible overshoot by placing adequate down-line survival parties, or the idiotic interservice squabble about just who would pick up this non-linear computing animal that had failed so miserably in his assigned tasks.

Let's not deride the industry, its scientists and production people, but give them a full measure of credit for the hard work and the results they have obtained in this primitive stage of this new business. However, please divide the blame a little more evenly by naming some of the scientists, engineers and production people who failed to provide sure-fire equipment for good environmental atmospheric control . . . failed to provide sure-fire re-entry control . . . failed to provide more than enough back-up fuel . . . and failed to provide more than enough down-line rescue parties that won't be fighting amongst themselves.

Let's not lose sight of the fact that Mr. Carpenter has produced in an outstanding manner and should not have to account to the public in the manner prescribed by the press. This man has a tre-

mendous amount of ability and should be given full credit.

About all that is left to be said, I guess, is that I feel that it is a tribute to your magazine that this is the first article, since you started publication, that hasn't been accepted with relish.

To your correspondent I would like to say: If you haven't been there, please don't knock those who have.

Captain Frank V. Martin
Auburn, Wash.

'Secret' Launchings

To the Editor:

Regarding your article and chart on the classified AF satellite launchings ("NASA Gives Data on 'Secret' Shots," M/R, May 28, p. 14), I would like to note the following:

—The given *Atlas-Agena* orbital parameters and payloads are more like those *Thor-Agena*-launched satellites. Only the satellite given as *Midas V* is relevant to previously identified *Atlas-Agena* missions. Since *Midas* and *Samos* were being launched on *Atlas-Agena* before their classification, wouldn't substituting *Discoverer*-type payloads aboard the same vehicle be a backward step in R&D?

—I disagree that *Discoverer 38* was an exception to the DOD policy, since *Discoverers 36* and *37* were identified after the secrecy cloak had been drawn over the *Atlas-Agena* flights. If the Feb. 21 *Thor-Agena* carried the first classified *Discoverer* you are partially correct. I am inclined to believe the March 23 directive first put *Discoverer* "underground."

—Don't the long time periods between launch and attempted capsule recovery seem a little unrealistic compared to previous *Discoverer* periods?

—*Discoverer 38's* capsule was recovered March 3, not March 21. Also, *Discover 37* was launched Jan. 13, not Jan. 15.

I was happy to observe that most of the launchings were successful, but I am confused since reading your article. Any comment or anyone who can help me clear this up?

PFC Arthur W. LeBrun
Ft. Bragg, N.C.

Discoverer 38's capsule was recovered on March 3, not March 21 as we stated. Reader LeBrun is also correct when he states that Discoverer 37 was launched on Jan. 13. As far as the rest of the letter is concerned, however, we would just point out that Discoverer is a component testing program—designed to provide the Air Force with a maximum amount of data on the effects of the space environment on propulsion, guidance systems, materials, bioastronautics and other space system techniques. Therefore, rather than being "a backward step in R&D," the use of an Atlas-Agena would give the Air Force a greater capability for such component testing, as would the ability to keep the payloads in orbit longer.—Ed.

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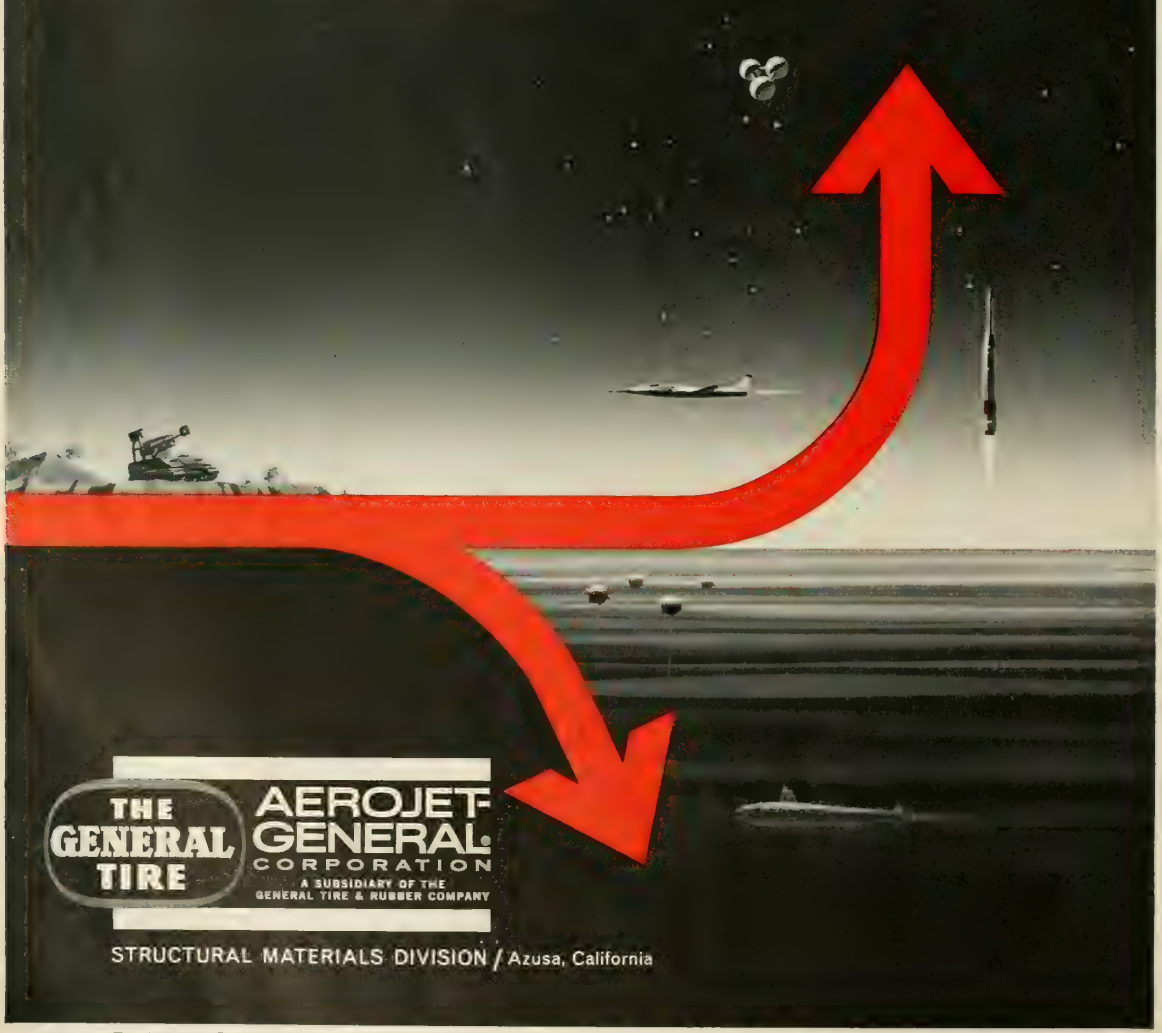
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The Countdown

WASHINGTON

AF Gets Bioastronautics Go-Ahead

Air Force has won a clear go-ahead on its bioastronautics program for orbiting of live specimens such as mice and chimpanzees. This will mean a revival of plans for monkey launches in the *Discoverer* series.

OSL Deep in the Heart of Texas

NASA's *Orbiting Space Laboratory* program soon will be shifted from Langley Research Center to the Manned Spacecraft Center in Houston, Tex. Once the transfer is made, NASA will be ready to go ahead with final design and hardware procurement.

Manned Space Battle Heating Up

Tempers are beginning to flare in the Pentagon as the battle for a military manned space program is stepped up. The unity which Defense Secretary McNamara stresses is no longer apparent. Knuckles were wrapped over Air Force plans for awarding of study contracts on the manned *Satellite Interceptor* project (see editorial, p. 46).

On the Demise of Advent

One of the primary reasons behind the Army's loss of the *Advent* program: failure to keep DOD officials informed on cost overruns and performance degradation. Air Force dissatisfaction also was a major factor.

Surveyor Usefulness Is Questioned

Some high NASA officials seriously doubt whether the *Surveyor* spacecraft will provide data on the lunar surface and environment in time to be of real value in planning Project *Apollo*. First *Surveyor* launch is not scheduled until mid-1964. Because of the problems of reliability in a complex spacecraft, it is expected to be well into 1966 before meaningful data is obtained. By that time, NASA plans to be making manned circumlunar flights.

Advent Boosters May Be Used Elsewhere

The two *Centaur* vehicles originally slated to launch the cancelled *Advent* satellite may be used in NASA's *Mariner* and *Surveyor* programs. No final decision has been made. The additional vehicles would not speed up either program since they won't be available until mid-1964.

Delay in NASA Appropriation Bill

Congress will not approve NASA's Fiscal '63 appropriation bill until well after the beginning of the fiscal year on July 1. That is now certain. It means NASA will be able to spend funds only at the level set in Fiscal 1962 until Congressional approval of the bill—expected in late July or early August.

Nova Future Still Looks Cloudy

NASA officials in Washington continue to downgrade the *Nova* superbooster. Associate Administrator Robert C. Seamans, Jr. told the Senate Space Committee that it will be used for interplanetary flights—excluding it completely from the *Apollo* program. Administrator James E. Webb told the same committee that "if rendezvous proves unfeasible, then we will proceed with *Nova*." All of this could mean that actual development of the booster is further off than the announced starting date of late Fiscal 1963.

Slippage in the Nuclear Program?

NASA has dropped plans to test a nuclear reactor every two months through the year. Harold B. Finger, director of nuclear rocket development, now says only that several reactors will be tested.

INDUSTRY

TVC is Major Concern of Air Force

AF is not pushing for exotic specific impulses in its big solid booster programs in the 100-in.-and-above sizes. It probably will be willing to settle for an ISP of about 245—or just a little more. A bigger concern is thrust vector control for the big ones—where, when, and how much of what to inject at what pressure.

AFSC Follows Up Management Conference

A panel of four general officers and two colonels has been set up by the Air Force Systems Command to follow up recommendations made by five industry-military panels at last month's AFSC Management Conference in Monterey, Calif. Recommendations which are considered within the capability of AFSC will be identified and controlled under a system of "Command Controlled Projects" to ensure follow-through.

Kuter Up for AIA President

AF Gen. Laurence S. Kuter, retiring chief of the North American Air Defense Command, has the inside track for the job of Aerospace Industries Assn. president. But he also is considering at least two very attractive offers from major firms in the missile/space industry, as well as a proposal from Air Transport Assn.

INTERNATIONAL

Official French Satellite Schedule

General Aubinière, executive director of France's National Space Studies Center (C.N.E.S.) has squelched speculation of an acceleration in that nation's first satellite launch date. He told M/R that the first French satellite in Project *Diamond* will be launched in early 1965. It will be placed in orbit by a three-stage rocket. Aubinière did not identify the satellite other than to state that the payload would be 176 lbs. with an orbit planned for an inclination of 30 deg., perigee 240 mi., and apogee 780 mi.

Breakthrough in Information Compression?

British scientists are claiming a breakthrough in information compression techniques—a method which enables television signals, computer data and other high-speed communications normally requiring a wide information channel to be carried over more conventional circuits, such as telephone wires. The information compression technique has been developed by a team led by Dr. Colin Cherry of the Imperial College of Science and Technology, University of London.

RFI PROBLEMS CALL FOR SERVICE BY SPECIALISTS

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The Missile/Space Week

Biggest Solid Firing Marred

Aerojet on June 9 successfully ignited 159 tons of solid propellant along 79 feet of segmented grain and reached a programmed thrust in excess of 700,000-lbs. before burnthrough occurred in the aft section (see p. 15). Company spokesmen say post-firing analysis points to the interface between the graphite insert and the exit nozzle as the failure zone. First indications of a malfunction came from vector control data and, had the booster been in a manned shot, the astronaut easily would have escaped. The 100-in. flightweight motor did not detonate and although burn-through occurred 45 seconds after ignition, a great deal of engineering data was acquired. The failure definitely occurred in the inert components of the aft segment. The segment joint held and most of the motor sections can be re-used. A *Titan II* engine, mounted piggy-back on the big solid for *Titan III* compatibility data was damaged but Aerojet and Air Force experts gathered enough information in the short time available. The firing, largest to date, all but wrapped up the firm's big solid program with the Air Force—although another 100-in. motor remains on the schedule. Aerojet Vice President R. D. Geckler said the company will be forced to make a substantial reduction in its large solids program if "something doesn't come along." Design studies, including handling methods for 260-in. motors, will continue.

Shots of the Week

Two X-*15* flights highlighted an otherwise slow week for missile and space vehicle launchings.

• The first *X-15* flight, June 7, was designed to gather data on the local air flow over the plane's surfaces at various flight conditions. Flown by NASA test pilot, Joe Walker, the *X-15* was banked into a 60 degree turn at various angles of attack while eleven sensors located on the plane's surface measured the air flow, dynamic pressure and mach number of the free air stream.

The powered flight, lasting 79 seconds, propelled the *X-15* to a speed of approximately 3800 mph and an altitude of 100,000 ft.

• In the second flight, June 12, AF Maj. Robert M. White held the *X-15* in the highest re-entry angle of attack yet attempted, bringing the high speed craft close to the angle at which it would lose stability and spin out of control. It was White's checkout flight in the No. 3 *X-15,* which carried him to an altitude of over 200,000 ft. and to a speed of about 3500 mph.

• *Titan II*—launched from Cape Canaveral June 7 on a planned 5000 mile test flight—fell short of its target but achieved most of its test objectives, according to an AF announcement.

Following second stage ignition, the AF said, telemetry contact with the missile became erratic. Cause of the malfunction was not known. It was the second R&D flight of the storable-fueled ICBM.

• A *Minuteman* missile was launched from Cape Canaveral June 8 in a 3000 mile flight to evaluate the general performance of the solid-fueled ICBM. The success was the 12th in 15 flights, the AF said.

Missile Base Strikes Down

Work stoppages at missile base construction sites last month dropped to "almost nothing" according to Labor Secretary Arthur Goldberg.

Only a "few hundred" man-days were lost in the millions of man-days worked, Goldberg told a House Labor subcommittee last week. The reduction in time lost, he said, was due to the "fine support from the unions, contractors and government agencies."

Douglas Responds to McClellan

"We believe it is to the government's advantage that the systems manager's fee has a relationship to the job done by his sub-contractors since there are many respects in which vigorous systems management can improve performance of suppliers," Donald W. Douglas, Jr. said in a letter to the Senate Permanent Investigations Subcommittee.

Taking up the dialogue where it left off when the profit hearings ended, Douglas said any procedure to limit fees on the basis of in-house work would be an "unfortunate inducement" for contractors to maximize their in-house work "to the possible detriment of overall systems performance."

So long as Pentagon administrators fully recognize the "manifold problems" facing the defense indus-

try, the Douglas letter said, there is no need for change in the basic procurement law.

However, Douglas added, administrative reforms to conserve the industry's technological capabilities and its power to react quickly to emergencies are overdue.

Army Seeks Missile "B" Bids

The Army held a bidders conference last week at Huntsville, Ala., for contractors interested in submitting bids on lightweight *Missile "B"*, which will replace *Honest John*, and to some extent *Lacrosse*.

Earlier details on *Missile B* released by the Army called for a missile with a five to 40 nautical-mile range, powered by either solid or prepackaged liquid storable fuel and capable of carrying either conventional or nuclear warheads.

Proposals are due at Army Ordnance Missile Command by mid July.

ONR Telescope Completed

An 85-foot, steerable radio telescope—built by Philco for the Office of Naval Research—was dedicated June 7 at Hat Creek, Calif.

Designed for extensive mapping of the galaxy and particularly the optically opaque gaseous hub at the center, the antenna has been specially designed to make measurements of the clouds of hydrogen which make up all of the matter in space.

By studying the distribution of hydrogen and tracing its motion, the telescope is expected to provide more detailed data than previously available on the structure and dynamics of the galaxy and the way it changes with time.

One of four major radio telescopes operated with the support of ONR, the Hat Creek dish will be operated by the University of Cal.

The Hat Creek Radio Astronomy Facility also includes an ONR-sponsored 33-foot radio antenna which can be used with the larger dish as a radio interferometer to pinpoint the location of distant radio sources.

Morrison Succeeds Heaton

Dr. Richard B. Morrison has been named director of Launch Vehicle and Propulsion Programs in NASA's Office of Space Sciences.

Space Sciences Director Dr. Homer E. Newell also announced the appointments of Dr. John F. Clark as Associate Director and Chief Scientist, and Dr. John E. Naugle to replace Clark as Director of Geophysics and Astronomy Programs.

Morrison succeeds Col. Donald H. Heaton, USAF, who has been reassigned to the Air Force Space Systems Command. He joins NASA from the University of Michigan, where he has been professor of aeronautical engineering and supervisor of the University's Aircraft Propulsion Laboratory since 1958.

Hypergolic Ignition Success

A highly reactive fluid sprayed up the nozzle end immediately ignited a flight-weight, 35-ton segmented, solid motor at United Technology Corp. The unit developed slightly more than 100,000-lbs. thrust in the test, which also involved an advanced thrust vector control and an extended-duration nozzle.

The hypergolic ignition system could be adapted to simultaneously ignite all cluster motors in a huge, multi-barrel booster.

Manned Saint Cancellation

Air Force Space Systems Division, which notified a group of major industry firms that they had been selected for three-month study contracts on the *Manned Satellite Interceptor* systems, abruptly notified them last week that plans had been cancelled.

Widely interpreted as a go-ahead for a military man-in-space program, the contract plans were dropped on orders from very high levels, according to SSD sources.

The *Manned Satellite Interceptor* system is a follow-on program to *Satellite Inspector*, a system for inspection of satellites in orbit. *Satellite Interceptor*, known also as *Saint II* or 621B, would provide the added capability of destroying or neutralizing hostile satellites.

Companies which were to have received contracts included North American, Lockheed, Boeing, McDonnell, Hughes and Raytheon.

(See editorial, p. 46.)

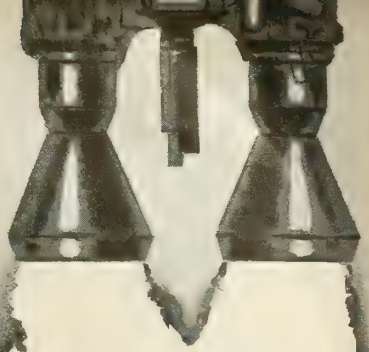
Astronauts for NASA

NASA has received more than 250 applications for the five to 10 astronaut positions it expects to fill this fall.

More than 200 of the applications came from civilians. NASA said many of this group are obviously not qualified and it is expected that this total will be screened down to about 20.

The military services were the source of 53 applications. All are expected to be given serious consideration.

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Army's Advent cancelled . . .

DOD Changes ComSat Plans

Air Force gets major responsibility as bids are prepared for two new systems, due to be operational by 1966

by James Trainor

REQUEST FOR bids are expected to go out to industry within the very near future for the development of two communications satellites to replace the *Advent* spacecraft which, until last week, had been under development by the Army.

In announcing what effectively was the cancellation of the *Advent* program, a Defense Department spokesman said that the department already had solicited informal bids on a new, lighter, high-altitude communications satellite. These bids, he said, showed that the DOD could obtain better performance at a lower cost by re-opening the competition for the spacecraft.

Also, the spokesman revealed, DOD will initiate a medium-altitude satellite communications program in order to "hedge our bets" on the high-altitude system.

To stimulate competition, both satellite systems will be on approximately the same time schedule: an initial operational capability in 1964 and fully operational by 1966.

Another major change in the DOD communications satellite program was the assignment to the Air Force of responsibility for the development, production and launch of all space devices to establish these systems. Previously, the Army's *Advent* Management Agency at Fort Monmouth, N.J. had responsibility for the *Advent* program.

This change, according to the DOD spokesman, is consistent with the March, 1961 directive of Secretary of Defense McNamara that the Air Force would be responsible for developing space systems for DOD. At that time, however, two exceptions were made: one to allow the Army to continue developing *Advent* and the other for the Navy to work on *Transit*.

• **ComSat to AF**—With the assignment of communications satellite responsibility to the Air Force, the only remaining exception is *Transit* which is expected to become operational in October, the Defense official noted. He added that he could see no future exceptions to the 1961 directive.

Thus, the Air Force, after a considerable, behind-the-scenes struggle, has won recognition of its primacy in space. AF dissatisfaction with Army and DOD handling of *Advent* had been plain for some time. (M/R, March 26, p. 43).

Although no longer responsible for the complete satellite program, the *Advent* Management Agency will continue to work on the development, implementation and operation of the ground environment: specifically, the ground communications stations and associated equipment.

A third entry into the communications satellite field is the Defense Communications Agency. Under the terms of the re-oriented program, DCA will assure the integration of the ground and space components. However, the Defense spokesman stressed, that DCA would not be the systems manager. In fact, he added, there would be no overall systems manager because, in the opinion of DOD, it was not necessary.

Prior to cancellation of the *Advent* program, DOD had spent some $170 million on the development of the satellite. How much of this will be a total loss, Defense officials were reluctant to estimate.

The techniques developed, and the data accumulated, for the *Advent* program would be directly applicable to the new high-altitude system, one official said. However, the two major contractors washed-out of the program, General Electric and Bendix, received $74 million and $23 million, respectively, prior to the re-orientation of the program.

In announcing the "technical redirection" of *Advent*, the Defense Department attributed the change to the necessity of bringing the program into consonance with available boosters.

Specifically, they said, the re-orientation was caused by the 15-month delay in the *Centaur* launch vehicle which was to be used to put the *Advent* into a 24-hour, synchronous orbit. In addition, a defense official said, the liquid-hydrogen upper stage had become marginal for lifting the 1250 pound satellite into its precise orbit.

However, not all of the blame for the two-year slippage in the *Advent* program could be placed on the *Centaur*, a DOD spokesman admitted.

• **Payload gains weight**—Part of the problem stemmed from the fact that the *Advent* payload—originally expected to weigh about 1000 pounds—had grown by some 25-30 percent before the flight tests had even begun. In addition, the program has been plagued by cost overruns—some of which took DOD by surprise. Prior to FY '62, over $80 million had been spent on *Advent*. During the current fiscal year, however, these costs skyrocketed from an estimated $68 million to $92 million.

The total cost of the development program had been initially estimated by the Army at $224 million.

Although a Defense spokesman characterized these over-runs as "par for the course," he also noted that the program had reached a stage where it was as economical, if not more so, to completely re-orient the program and, at the same time, obtain a system with better performance at a lower cost and an earlier operational date.

The Army's management of the *Advent* program was characterized by a Defense official as "neither the best nor the worst that I have been associated with."

In describing the new high-altitude communications satellite program, a Defense official said that it would be fully-stabilized and fully station-keeping but not necessarily synchronous.

Like *Advent*, the new satellite will be a wide-bandwidth, active repeater with encryption and anti-jamming capability. However, the new system will weigh only 500 pounds as opposed to *Advent's* almost 1300 pounds and will be able to be launched by an *Atlas-Agena D*.

The reduction in satellite weight, the spokesman said, will not have a

consequent effect on the communications capability. In fact, the weight reduction is expected to result in very little degradation in the satellite payload.

Depending on the reliability achieved with the new system, the high altitude communications system would consist of more than three and less than 10 satellites to provide world-wide coverage.

• **Lighthouse out**—One of the chief technical advances which make it possible to maintain communications capacity with a lighter-weight vehicle in the new satellite system is the traveling wave tube—currently planned for use in NASA's *SYNCOM* communications satellite. This tube would be substituted for the lighthouse tube used in *Advent* and would also change the bandwidth used for the satellite.

Another weight-saving feature of the new satellite system will be its reduced power requirements. Although Defense officials would not specify the power requirements for the new system, they will be considerably less than the 650 watts developed by the 35,000 solar cells used on *Advent* to accommodate the expected power drain of 480 watts.

Although the method of stabilizing the new satellite was not discussed in detail, further weight savings could be achieved by using the gyro-stabilization used in *SYNCOM* rather than the *Advent's* cold and hot gas attitude control system.

In fact, much of the technology used in *SYNCOM*, according to John Rubel, Assistant Secretary of Defense, Research and Engineering, was developed by DOD after the *Advent* program had been underway for about 18 months. However, rather than disturb the *Advent* program, DOD decided to let NASA develop and exploit the technology. Both the frequency bands and the ground stations developed for *Advent* are also compatible with *SYNCOM*. It appears likely therefore that DOD will use much of this technology in its new satellite system with the addition of communications security devices.

The *Advent* ground stations at Fort Dix, N.J., and Camp Roberts, Calif., will not be changed appreciably, according to the DOD spokesman. However, he noted, the Army is still faced with extremely complex problems in developing a switching system that can recognize when a satellite is in range and delay transmissions until the satellite is in the proper position. "We have built many switching systems," he noted, "but never any with this capability."

• **Two-year gain**—By using the *Atlas-Agena D* and developing the lighter satellite, DOD feels it can gain two years over the present *Advent* schedule and have an initial operational capability in 1964 rather than 1966. This would still leave them six months to a year behind the 1963 capability which they estimated they would have as late as August, 1961.

The 1964 capability would considerably relieve the pressure being exerted by the Joint Chiefs of Staff and the Defense Communications Agency on DDR&E to get a communications satellite system in operation.

This pressure undoubtedly contributed to DDR&E's decision to initiate a medium-altitude, active repeater system to hedge its bet on the high altitude system.

Planned for launch into a 5-7000 mile orbit, the medium-altitude system would be comparable to NASA's *Relay* communications satellite. However, it is expected that the satellite will be lighter than the 150-pound NASA spacecraft.

Forty or fifty of these satellites would be put into orbit using the multiple-launch concept being developed by NASA for its *Rebound*, passive-reflector communications satellite program. However, a DOD spokesman admits that, at present, the technology is not available for multiple launches and that, if it does not become available, the economics of the medium-altitude system become problematical.

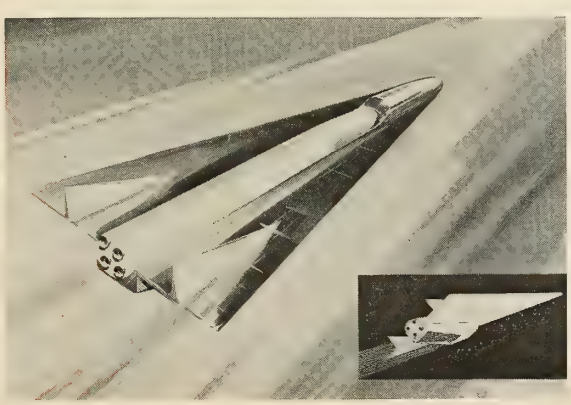
Although duplicatory, the two systems will fulfill different operational missions, the spokesman said, with the medium-altitude system utilizing a narrower, voice and teletype bandwidth. Also, he said, since Parkinson's Law extends to communications as well, there are enough requirements to utilize both systems.

• **Cost parameters**—The medium-altitude system will be launched into polar orbit, the spokesman said. In testimony before Congress in August of last year, DOD officials estimated that the development of a medium-altitude system would cost between $10-$140 million "depending on such factors as orbit height, type and location of ground terminals and complexity of the repeaters in orbit."

Cancellation of the *Advent* program, will have a direct impact on both General Electric and Bendix. GE estimates that the cancellation will result in the loss of some 1100 jobs in its Missiles & Space Vehicle Department. Of these, some 600 will be transferred to advanced research programs within the Department. The remaining 500, however, will be laid off in July. The impact on Bendix is not yet known.

General Electric had been responsible for the satellite and flight hardware while Bendix was responsible for the satellite and ground communications package. ⌗

Bristol-Siddeley proposes sophisticated booster



A RECOVERABLE space booster proposed by Bristol Siddeley Engines Ltd. would be capable of placing payloads of 50 tons into Earth orbit at a cost per lb. about one-tenth that of the *Atlas-Agena B*.

Using a hypersonic, air-breathing first stage, the high-performance vehicle would reach an altitude of 110,000 ft. and a velocity of 12,000 ft./sec. before the three-stage rocket would be released and ignited.

Such a launching system, the British firm claims, is "well in advance of anything proposed in the present NASA program." However, the firm also admits that "a great deal of research must be completed" before the space launching system can be developed.

UN Weather Satellite Net Planned

GENEVA—A ten-year plan for development of a world-wide system of weather reporting based on meteorological satellites has been agreed to by representatives of the United States and the Soviet Union.

The plan calls for establishment of World Weather Centers in Washington and Moscow within the next three years. Details were contained in the first report of the World Meteorological Organization which was forwarded last week for examination by the Economic and Social Council of the United Nations at its session here next month and by the General Assembly this fall.

Satellite observations are to be combined with rocket and balloon observations and with those from land, ship and aircraft stations to enable detection and tracking of every major storm.

The report was prepared in consultation with Russia's Prof. Va. A. Bugaev and Dr. Harry Wexler of the United States Weather Bureau. The intent is to set up a worldwide weather observation and prediction system.

The plan calls for use of satellites for both weather observation and communication.

The World Weather Centers in Washington and Moscow would have access to world-wide data originating in the system. They would be equipped for processing, analyzing and distributing the data. A third center was suggested for the Southern Hemisphere with no location named.

• **World weather center** — The report said arrangements already are underway to enlarge the National Meteorological Center of the U.S. Weather Bureau in Washington into a World Center in which meteorologists from other countries will be asked to participate. The Hydrometeorological Administration in the Soviet Union intends to set up a World Center, the report stated. Regional centers also are called for in the scheme, the first to be set up in Europe by 1965.

The report assumes that production and launching of satellites will continue to be the responsibility of individual governments. But it calls for an internationally co-ordinated launch plan for meteorological satellites, with rapid dissemination of information received from them to other states.

Both the U.S. and the U.S.S.R. delegates have agreed to this.

Dr. Hugh L. Dryden, NASA's deputy administrator, said acceptance of the recommendations by the two governments would mark an important step in space cooperation. Soviet Prof. Anatoli Blagonravov called the talks most important.

Coordination would include agreement on orbits and instrumentation.

• **Plan outlined**—The WMO report laid out a five-step plan for the coming decade:

• Development of an internationally coordinated plan for meteorological satellites.

• Establishment of the World Weather Watch.

• Augmentation of the present network of conventional meteorological observations in areas where they are sparse or non-existent.

• Improvement of telecommunications networks for the exchange of both satellite information and conventional meteorological observations.

• Establishment of World Meteorological Organization Advisory Committee from other interested international organizations.

U.S.-Soviet Disagreement

GENEVA—*The Soviet Union and the United States failed to reach agreement here on a series of nine legal principles for control of outer space proposed by the Russians.*

Leonard Meeker of the U.S. State Dept.'s legal section rejected the Soviet program on June 7 only minutes after it had been presented by Soviet delegate Grigori Tunkin. He said the U.S. objected in particular to a Soviet provision which he said would prevent one state from carrying out space projects if one or more other countries objected. This, Meeker said, amounted to a Soviet veto over all space projects.

The U.S. put forward a counter-proposal in the 28-nation legal subcommittee of the United Nations Committee on Peaceful Uses of Outer Space. It called for assistance to stranded astronauts, return of downed space vehicles and personnel to their own country, and establishment of an advisory panel on compensation for damage caused by falling space ships.

The coordination plan should include allocation of interference-free frequency bands for communication with meteorological satellites, the WMO said.

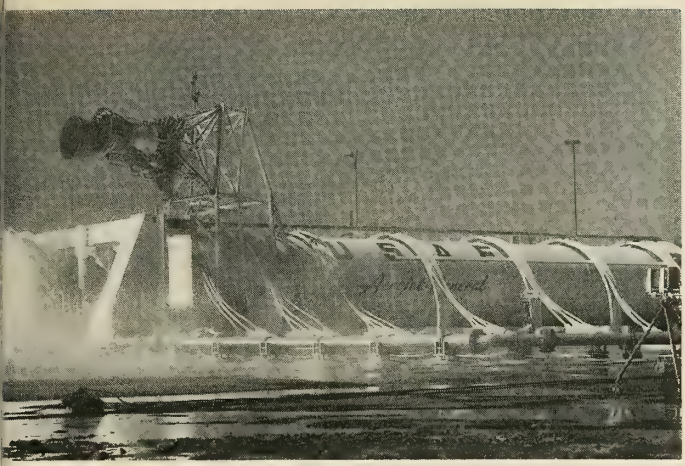
It set forth these other major requirements for optimum utilization of a weather satellite network: continuous existence of one or more satellites transmitting useful weather information; read-out stations in sufficient number and with adequate facilities to ensure accurate reception and processing of data for global coverage and utilization; further development of techniques for operational use of satellite data; an adequate network of conventional and auxiliary meteorological observations to provide the broadscale framework for detailed observations obtainable from satellites and to help interpret those observations; communication facilities for prompt world-wide dissemination of processed data for operational purposes; broadening of World Meteorological Data Centers to include satellite data to make it available for research purposes; a long-range research program to incorporate satellite data.

• **Varied sensors** — "Toward the end of the present decade," the WMO report said, "one may visualize a system of meteorological satellites, each with sufficient capacity to carry meteorological sensors of many types, storage and possibly initial data-processing facilities and communications equipment. By this means, a world-wide system of line-of-sight communications could be established which would replace the conventional meteorological communications system in transmitting both word and pictorial traffic."

Meteorological instruments installed on satellites by different countries should have comparable accuracy in radiative-thermal (actinometric) and other measurements as well as in resolution of television sensors, it was suggested.

With this, there would be requirements for establishing uniform methods of weather satellite data-processing, standardization of methods for graphical representation of data in the form of charts and codes for compact data transmission internationally.

For observation of atmospheric layers below 30 km. (18.6 miles), a concerted effort should be made in the next five years to standardize available sounding devices, the WMO said. ⌗



Aerojet-General Photograph



Missiles and Rockets Photograph

"Highly successful test . . . work on big solids is continuing."

AEROJET-GENERAL CORP. released the following press announcement on the June 9 firing of its segmented solid rocket: "A new American thrust level of 700,000 lbs. for solid-propellant rockets was set here today under a U.S. Air Force program. The highly successful test was marred when the intense heat called for caused a burn-through in the rocket casing, allowing gas to escape. The rocket did not explode, nor did its parts scatter. Instead, the escaping gas continued to burn through the aft-section until the 159 tons of propellant was consumed. Richard D. Geckler, Aerojet-General Corp. vice president and manager of the firm's Solid Rocket Plant, said 'The overall success of the firing confirms our confidence in large solid rockets.' Air Force representatives who viewed the test expressed their satisfaction with the data obtained, relating to: a) Record thrust of over 700,000 lbs.; b) Successful ignition of the largest mass of propellant ever put together, and c) Significant information on steering large motors. Work on big solids by the company is continuing."

Tiros V Weather Satellite To Study Wider Area of Earth

NASA WILL ATTEMPT to get greater coverage from its fifth *Tiros* weather satellite, scheduled for launch this week.

Tiros V will be launched into an orbit inclined 58 degrees from the equator—10 degrees more than its four predecessors. If successful, it will provide weather coverage as far north as the 65th parallel. This will include the ice break-up in the northern latitudes.

The satellite will be launched from Cape Canaveral no earlier than June 19, on a three-stage *Delta* rocket. It will orbit the Earth every 97 minutes at an altitude of approximately 350 nautical miles.

Besides the study of the ice break-up, one of *Tiros V's* main objectives will be the mapping of tropical storms.

It is estimated that it will view the Northern Hemisphere with its TV cameras for 10 days, view the Southern Hemisphere for the next 38 days, and then head north again. This schedule will put the satellite over the Northern Hemisphere's hurricane-typhoon belts during the hurricane season.

• **Instrumentation** — The Tegea medium-angle lens, proved successful on the *Tiros IV*, will be used again, as will the wide-angle Elgeet lens used on all previous *Tiros* spacecraft. The Tegea lens reduces distortion and gives a somewhat clearer picture while preserving relatively large area coverage. When this camera is pointed straight down from an altitude of 350 miles, it will transmit pictures of an area about 450 miles on each side. The wide-angle lens covers an area of about 750 miles square.

Like previous *Tiros* satellites, the spacecraft will carry two magnetic tape recorders, each of which can record as many as 32 successive pictures. When the *Tiros* is within the 1500-mile range of one of the Wallops Station, Va., and Pt. Mugu, Calif., tracking stations the pictures can be transmitted Earthward on command. The tape is then erased and rewound for the next recording. Also, the recorder can be bypassed and additional pictures directly transmitted.

Other instrumentation will include remote control electronic clocks for triggering the cameras when out of range of the ground stations, beacon transmitters, horizon scanners, telemetry circuits and a magnetic orientation control system.

In addition, infrared radiation experiments, essentially the same as those conducted in previous *Tiros* orbits, will be included. The purpose of these experiments is to learn how much solar energy is absorbed and reflected, and how much infrared radiation is emitted, by the Earth and its atmosphere, and to further develop a means of determining the nighttime cloud cover of the Earth.

Power for the operations of the electronic equipment is furnished by nickel-cadmium storage batteries charged by more than 9000 solar cells mounted on the top and sides of the spacecraft.

NASA's Goddard Space Flight Center, Greenbelt, Md., is responsible for overall technical direction of the project, including tracking, command, data acquisition, and the infrared radiation experiments. The Office of Meteorological Satellite Activities of the U.S. Weather Bureau is responsible for implementation and coordination of the operational use of the cloud picture data and for their research use.

Other U.S. weather services participate in both operational and research use. ⌘

Final details pending . . .

NASA To Use More Incentive Contracts

Bendix wins first major NASA incentive award as space agency gains experience in estimating costs of engines

by Hal Taylor

NASA PROCUREMENT officials plan to move heavily into the area of incentive contracting.

The projects most likely to be affected are follow-on contracts for some of the agency's rocket engines and such satellite and spacecraft programs as *Nimbus, Aeros,* and the *Advanced Relay* and *Syncom* communication satellite systems.

Ernest R. Brackett, director of space agency contracting, told MISSILES AND ROCKETS, "while final details haven't been completed, we hope to award more incentive-type contracts."

His statement was made as the space agency announced its first major incentive award—a $10-million contract to the Bendix Corp. covering operation and maintenance of five stations in the *Mercury* tracking network for 1963 and 1964.

Brackett declared that the contract could well be the first of a long line of NASA incentive contracts which would pay a special fee for superior cost-cutting or performance.

He said that both he and NASA Administrator James E. Webb are in favor of them.

• **Gaining experience**—NASA has lagged behind the DOD in the use of this comparatively new type of contract. The gap has been attributed to the space agency's lack of experience in the development of the unique types of equipment required by its program.

"Now we're getting to the point where we have some experience in getting targets on which to base an incentive award," Brackett said.

As an example, he noted that NASA is now getting a pretty good indication of how much it costs to build a rocket engine for its big boosters, and that follow-on contracts for additional engines could be of the incentive type.

The engines could include the F-1, J-2, and RL-10. Other possibilities he said, were the advanced weather and communications satellites.

Cost data on these would be based on the space agency's experience with the *Relay* and *Tiros* satellite programs.

"We're still studying them and no final decision has been made," Brackett said.

The decision is expected in September. Webb has set up a special Procurement Study committee and its report is scheduled for that month.

Besides the question of how NASA can award more incentive contracts, it is also working on a review of NASA's methods of contractor selection, the procedures used to determine what firms will be permitted to bid on contracts, and its contract performance evaluation.

It is clear that many of NASA procurement officials would prefer to stick to the cost-plus-fixed-fee type of contract, which is easy to administer in comparison with the incentive type. The support of both Brackett and Webb should mean, however, that this slight opposition will be overruled.

That NASA is moving toward incentives is sharply illustrated by recent developments.

First, a small incentive contract was awarded by the Goddard Space Flight Center. The Bendix contract followed and it is reported that NASA's Ames Research Center will make an incentive award in the near future.

Brackett said that NASA incentive contracts would be similar to the DOD type contract and that no major changes are likely. The DOD contracts enable firms to earn higher profits for exceptional performance, cost cutting, or superior reliability of the completed system.

Currently, the Air Force—which awards most of DOD's incentives—is authorized to pay a 10% fee for superior performance for production contracts and 15% for R&D contracts. Despite the statutory limitation, the Air Force requires approval at the Secretary's level for fees in excess of 7% for production contracts and 10% for research and development contracts.

Brackett said that what fees NASA may pay under incentives will be determined by the study committee.

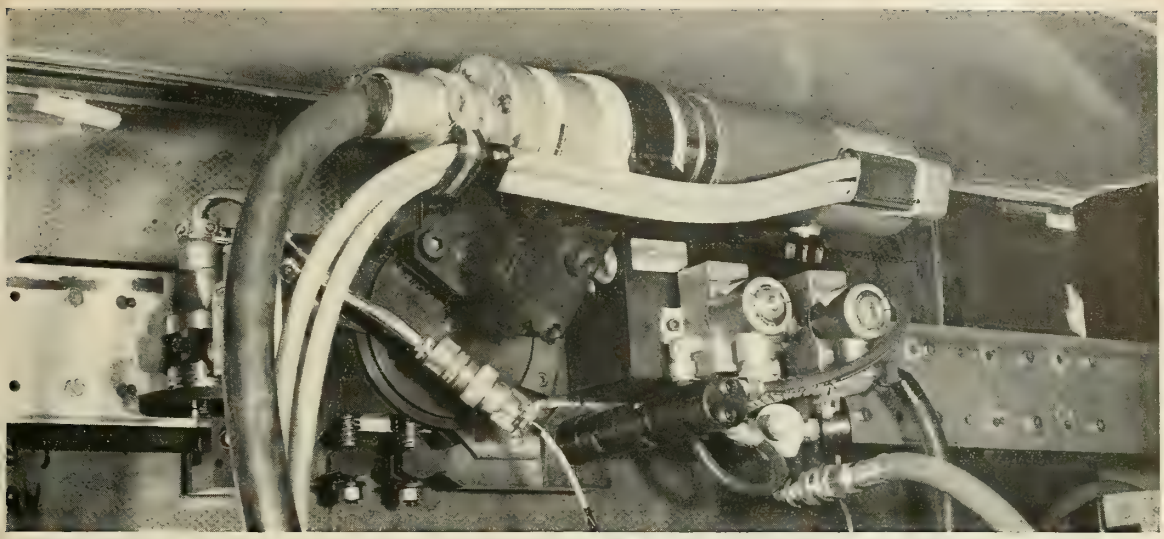
The award of the *Mercury* tracking network service contract winds up a procurement action which began last December. At that time, seven electronics firms submitted proposals. In February, NASA trimmed the list to only two firms, Bendix and RCA. Bendix was always considered the leading contender because it has operated the stations since July 1, 1961.

NASA's Goddard Space Flight Center, Greenbelt, Md., which will monitor Bendix performance, said the company will be able to earn incentive payments above its fixed fee by demonstrated superior performance.

Incentive contracts have been used before, particularly in research and development "hardware" contracts. This contract, however, is believed to be the first awarded by any agency to provide a monetary incentive for outstanding performance in service-type work.

In addition to the incentive feature, contract provisions include ceilings on indirect costs, options for extension of the contract under the same terms as the initial contract, and the ability to retain key employees within the *Mercury* program should another contractor be selected at a later date.

Under the award, Bendix will operate and maintain stations at Bermuda; Grand Canary Island; Kano, Nigeria; Zanzibar; and Guaymas, Mexico. It will also maintain and operate a training facility at NASA's Wallops Station, Wallops Island, Virginia, and operate aircraft which will service and calibrate the electronics communications equipment at all stations. In addition, the contract provides for a depot for logistics support at Owings Mills, Md. ⁂



The "Skate" carrying the 100 KVCP x-ray tube inspecting honeycomb section destined for a B-70 major assembly.

They put Radiography on the Honeycomb Production Line

North American Aviation, Inc. combines machining, welding, and x-ray inspection in one setup, increases production, improves quality and cuts costs

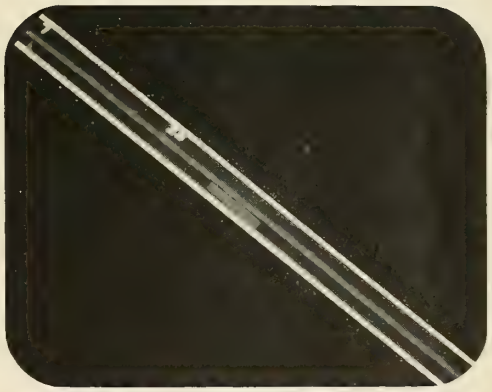
Honeycomb construction is of strategic importance in the manufacture of modern aircraft and missiles. But manufacturing costs run high. And utmost quality is a must.

So North American Aviation, Inc. developed the "Skate." Mounted on a track the "Skate" first carries the tool that prepares edges for welding, then the TIG welding heads, and finally the x-ray tube which travels the length of the weld. A strip of Kodak Industrial X-ray Film, Type AA, is placed behind the weld.

With this setup, North American Aviation has been able to increase production rates, improve quality, and cut costs.

And with radiographic inspection, there is not only immediate evidence of freedom from defects but a lasting record to prove it.

Today radiography is inspecting castings, welds, and enclosed assemblies of all kinds. It is helping maintain quality and improve production technics. It can help in your business, too. To find out how, talk to your Kodak x-ray dealer or write us to have a Kodak Technical Sales Representative call.



Section of a 7′ strip of 16mm Kodak Industrial X-ray Film, Type AA, showing good butt fusion weld.

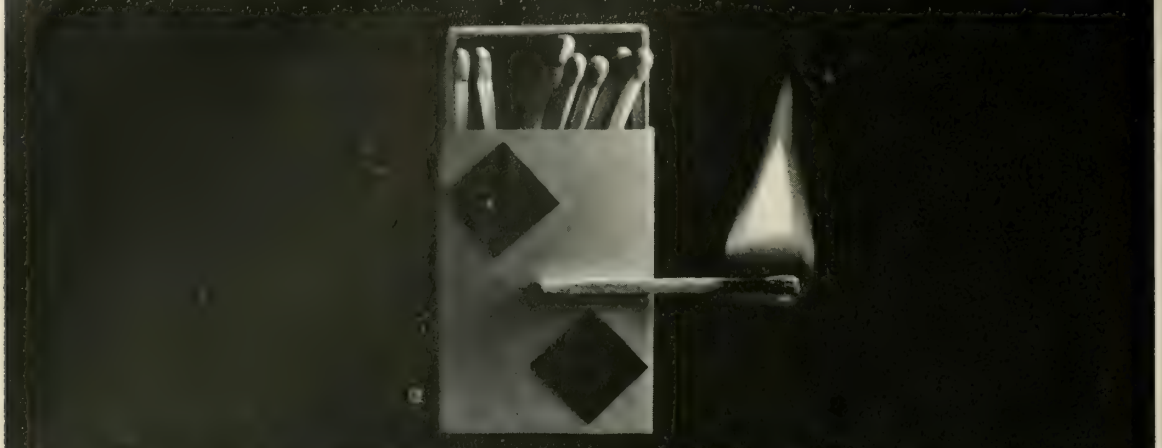
Now . . . Ready Pack in ROLLS and SHEETS
Kodak Industrial X-ray Film, Types AA and M
in 200-ft. rolls (16mm, 35mm, 70mm) and
sheets (8 x 10, 10 x 12, 11 x 14, 14 x 17).

- No darkroom loading—film sealed in a lighttight envelope.
- Just place Ready Pack in position and expose.
- Film protected from dust, dirt, light, and moisture.
- In the darkroom—remove film from envelope and process.

EASTMAN KODAK COMPANY
X-ray Sales Division • Rochester 4, N.Y.

Kodak
TRADEMARK

ENGINEERS & SCIENTISTS—No. 2 in a Series Prepared to Give Insight Into the Scope of R & D Opportunities at Allegany Ballistics Laboratory, operated for the U. S. Navy by Hercules Powder Company



Dethroning the Safety Match (Century-Old Symbol of Ignition Performance)

Ever since Lundstrom invented the safety match in 1855 this little device has stood for safe, fast, reliable ignition. However, the time has come for Space Age technology to receive its due. A highly qualified candidate for the new symbol of firing performance is the ALTAIR I MOTOR, developed by the engineers and scientists of Allegany Ballistics Laboratory.

To date this pioneer motor has scored a 100% *on-time* firing record, pre-programmed to .1 sec., due to important technical advances originated at ABL, including an optimum igniter system. At time of writing, ALTAIR I has provided *thrust for 50 of the nation's satellites, test vehicles, space and atmosphere probes.* Many more launchings are scheduled.

A NEW ALTAIR — WITH HIGHER Isp AND NEW IGNITION TECHNIQUES

For NASA's advanced Scout launch vehicle, Allegany Ballistics Laboratory (operated by Hercules for the USN since 1945) is designing and fabricating the ALTAIR II. A hotter propellant has been developed, providing 5,000 lbs. average thrust in 28 sec. compared with 3,100 in 38 sec. for its forerunner. Matching of an ignition system to the new high energy propellant posed some stringent problems —now solved through the Laboratory's intensive research program, as recent test firings have demonstrated.

OPPORTUNITIES TODAY AT ABL IN ALL ASPECTS OF ROCKET R & D

Ignition and propellants are only two elements of ABL's continuing endeavor, directed at raising the state of the art across the entire spectrum of rocketry, as well as creating new families of rocket boosters and motors for specific missions. Among PAST ACHIEVEMENTS: Deacon, Talos, Terrier, Little John, Honest John, Nike, Bullpup, final stage motors for Polaris A-2 and Minuteman. CURRENT PROGRAMS include: the new Polaris A-3, advanced Altair and Antares, mid-range Typhon, long-range Typhon and the Upstart.

Rocketry at ABL is a multi-disciplinary effort, calling for close and mutually rewarding collaboration between:

AERONAUTICAL, MECHANICAL, CHEMICAL AND ELECTRICAL ENGINEERS; CHEMISTS, PHYSICISTS AND MATHEMATICIANS

While previous experience in rocketry is welcomed, demonstrated capability in a man's own field is the prime criterion for a position with Hercules at Allegany Ballistics Laboratory, the nation's foremost rocket research laboratory. For further information about openings outlined at the right contact Mr. W. D. Linkenhoker, Technical Personnel.

Look at the Record of **ALTAIR IX248**— Critical Upper Stage Propulsion Unit for Satellites, Probes, Test Vehicles.



	TEST FIRINGS	SUCCESSES*	
	24	24	(100%)
	LAUNCHINGS		
	50	50	(100%)

*when lower stages performed correctly

▶ Rocket Research & Development Positions

AE's, ME's, ChE's, Chemists, Physicists (BS, MS, PhD). ADVANCE DESIGN RESEARCH: studies to establish new rocket system concepts; preliminary design criteria.

MECHANICAL DESIGN RESEARCH: materials behavior; exhaust gas control; insulation; propellant combustion; hardware.

DESIGN & DEVELOPMENT: complete rocket motors including pressure vessels, nozzles, accessories. (Must know mechanics.)

SPECIAL STUDIES, ANALYSES: (8-10 years experience essential) heat transfer; fluid dynamics; systems analysis; internal & external rocket and missile ballistics.

AE's, ME's, ChE's, Chemists (BS). QUALITY CONTROL, RELIABILITY, TEST, FACILITY ENGINEERING, CONTRACT ADMINISTRATION. Test engineering includes analysis static firing test stands and associated hardware.

EE's, ChE's, ME's (BS, MS). INSTRUMENTATION: D&D instrumentation to obtain test firing data; also for process control.

Mathematicians (MS, PhD). DATA REDUCTION & ADVANCED PROGRAMMING: Apply statistical methods to QC, reliability, research data.

Physicists (MS, PhD) **Chemists** (PhD). Inorganic, Physical ACOUSTICAL RESEARCH: behavior of burning rockets under different acoustical phenomena. Propellant & High Temperature Materials Research.

Allegany Ballistics Laboratory

OPERATED BY HERCULES POWDER COMPANY

FOR BUREAU OF NAVAL WEAPONS

CUMBERLAND, MARYLAND

The Nation's Foremost Rocket Research Laboratory

All qualified applicants will receive consideration for employment without regard to race, creed, color or national origin. U. S. CITIZENSHIP REQUIRED.

Technical Countdown

ELECTRONICS

High-Energy Glass Laser Tested

Energy outputs above 100 joules using a neodymium-doped glass laser have been achieved by American Optical Co. With an 18-in. x ¼-in. dia. clad rod, Dr. Elias Snitzer of AO's Research Center says he was able to obtain an output of 113 joules with a pulse duration of under 2 milliseconds. Beam spread was 10°, light source was a straight Kelmite flash tube in intimate contact with the laser.

Radar Study Requires Massive Towers

Three 400-ft. towers now under construction by Avco Corp. will be used to suspend targets for radar measurement studies. It's hoped that the models, located 300 ft. up and directly over ground-level radar dishes, will minimize unwanted reflections from ground obstacles. The studies will be performed by Avco's Research and Advanced Development Division.

New Optical System for Space Track

An advanced optical surveillance system employing an image orthicon and data-correlation techniques will be developed by RCA Laboratories for the Air Force. Designed to be a part of Electronic Systems Division's 496L (Space Track) System, the telescope will be developed to extend the present range of radar detection and will not be restricted to surveillance of Earth satellites, the Air Force asserts. The present contract totals $2.8 million.

Honeycombed Space Dish To Be Built

An experimental solar concentrator for thermionic power systems in spacecraft will be developed by Fairchild Stratos under a recent NASA contract. Aim of the project, says Langley Research Center, is to produce a very lightweight but highly efficient mirror capable of surviving both launch and space environments. Fairchild will employ an adhesive-bonded aluminum honeycomb structure for the 5-ft.-dia. parabolic reflector.

'Pop-Up' Antenna Avoids Nuclear Blasts

Hardened missile sites may be equipped with buried antennas capable of immediate erection after a nuclear blast to re-establish communications. Sylvania Electronic Systems developed the "pop-up" antenna and displayed models at the Armed Forces Communications and Electronics Association meeting in Washington last week. The antenna's performance would be the equivalent of a 120-ft.-high conventional unit. It is powered for both operation and erection with a single cable.

Space Microwave Radio System Developed

General Telephone and Electronics Corp. has built a solid-state microwave radio system consisting of transmitters and receiver units aimed at applications in the "synchronous" satellite communications network. The transmitter is smaller than a carton of cigarettes and designed to operate on 2 watts output power within the S-band. The system was developed for the Air Force by the Sylvania division of GT&E.

ADVANCED MATERIALS

Rock Island to Establish Hydraulic List

A qualified products list for petroleum-based, missile hydraulic fluids under specification MIL-H-46004 (Ord.) will be established by the Rock Island Arsenal, Department of the Army. Companies having products meeting this requirement are requested to contact the Commanding Officer of the Arsenal, Rock Island, Ill. Attention: Laboratory. Awards will be made only for such products as have been tested and approved for inclusion in the list.

Gas Turbine Life Tied to Dust Ingestion

Southwest Research Institute scientists have found that gas turbines can be eroded by dust until failure before normally monitored data gives any indication that this is occurring. Turbine life is directly related to dust ingestion, but total erosion is independent of dust concentration. Erosion has its causes in the weight ingested. The researchers established filter requirements down to the removal of all dust particles above 2-3 microns diameter for normal field operation.

Thermal Diffusivity Determined by Flash

A flash method for determining the thermal diffusivity, heat capacity and thermal conductivity of materials has been developed by the Naval Radiological Defense Lab. The process uses a high-intensity, short-duration light pulse which is absorbed in the front surface of a thermally insulated specimen a few millimeters thick coated with camphor black. The resulting temperature history of the rear surface is measured with a thermocouple and recorded with an oscilloscope and camera. The method is economical, both in equipment and material specimen size.

24-Kt. Gold Suit Perfected for Fuelers

An airtight suit weighing only 5.5 lbs., fabricated from Teflon fibers and film then metallized under vacuum with gold, has been developed by Snyder Mfg. Co. The suit fabric is patented by DuPont. A lightweight, two-way communications set is provided, and air is supplied from external or backpack sources. The gold layer safely reflects instantaneous flash temperatures as high as 3000°F and sustained temperatures up to 500°F. The suit is designed for rocket fuel handling.

PROPULSION

Sounding Rockets Fired 'Piggy-Back'

The Navy recently fired its *High-Altitude Sounding Projectile (HASP)* from a *Loki* launch-tube attached "piggy-back" to the barrel of a modern 5-in. rapid-fire naval rifle. The shot points the way to easier weather surveillance by Navy ships. The *HASP* payload—usually chaff for determining wind vector—is to be increased to include a parachute-supported radio sonde to telemeter temperatures and pressures from altitude.

SPECIAL LUNAR REPORT

AS THE UNITED STATES builds up its prowess in propulsion, guidance and vehicle construction for the supreme task of hurtling man to the Moon, it is also painstakingly developing the means to land him safely on the lunar surface and to support him once he has landed.

In this special report, MISSILES AND ROCKETS examines the broad range of lunar studies under way or planned (opposite page) and takes a close look at the tricky business of soft-landing (p. 26).



FIRST lunar photograph taken with 43-in. reflecting telescope at Pic du Midi Observatory: K-24 camera, Kodak Panatomic-X, 1/75-sec., f/15. (Top of photo is South.)

U.S. Steps Up Planning for Moon

Lunar environment, base-construction, mapping are studied with an eye to multibillion-dollar exploration

by William Beller

EXPLORATION of the lunar surface is expected to be a multibillion-dollar project in the 1970's.

Already, government agencies are beginning to fund the studies needed for this effort. These range from an examination of the problems of soft-landing men on the Moon's surface (see p. 26) to plans for an elaborate lunar base.

The Army Corps of Engineers, for instance, is finishing the preliminary design of an estimated $6-million lunar-construction research facility intended to test materials, techniques and equipment meant for a lunar environment.

The National Aeronautics and Space Administration, through its Marshall Space Flight Center, is proposing a $2.8-million program of studies during the next two fiscal years in lunar-base construction and operations.

The Air Force Office of Aerospace Research, through Cambridge Research Laboratories (AFCRL), is continuing to support contractor investigations in lunar and planetary geophysics at an annual rate of $1.4 million.

NASA is cooperating on lunar mapping projects with both the Army and Air Force.

Boeing, Douglas, Martin, North American, and Northrop—among other large companies—are investigating ways to help man work on the Moon.

• **Billion-dollar business**—Although the government money now going into such post-*Apollo* projects is still measured in the low millions, it is almost certain that funding will soar as soon as the first lunar-lander telemeters to Earth information on what the Moon is made of. Then the engineers will know what their materials of construction will be, and the scientists what substances they will be able to derive.

Another spurt in funding for man's stay on the Moon is expected when the *Apollo* lunar landing draws closer.

Meanwhile, foundations are beginning to be laid for the lunar-exploration program, which one NASA official predicts will become the major space effort in the 1970's.

Industry is initiating and sponsoring lunar research for hard-headed business reasons. John DeNike, a Martin Company special program manager in advanced design, says that knowing what it will take to support a man on the Moon "gives you a feel for the type of Earth-Moon transportation systems that will be needed—and we're in the business of providing boosters and spacecraft. On the long-term basis, the Martin Co. wants to play a substantial part in providing materials and equipmen for lunar bases."

• **Moon base called for**—NASA plans to set up a permanent or semi-permanent manned lunar base similar in concept to the ones already established by the U.S. in the Antarctic, Dr. William Lee of NASA's Office of Manned Space Flight, told MISSILES AND ROCKETS.

He defined a semi-permanent base as one supporting man for more than two weeks; but he observed that to be really useful man should be able to work in a lunar base for at least four weeks.

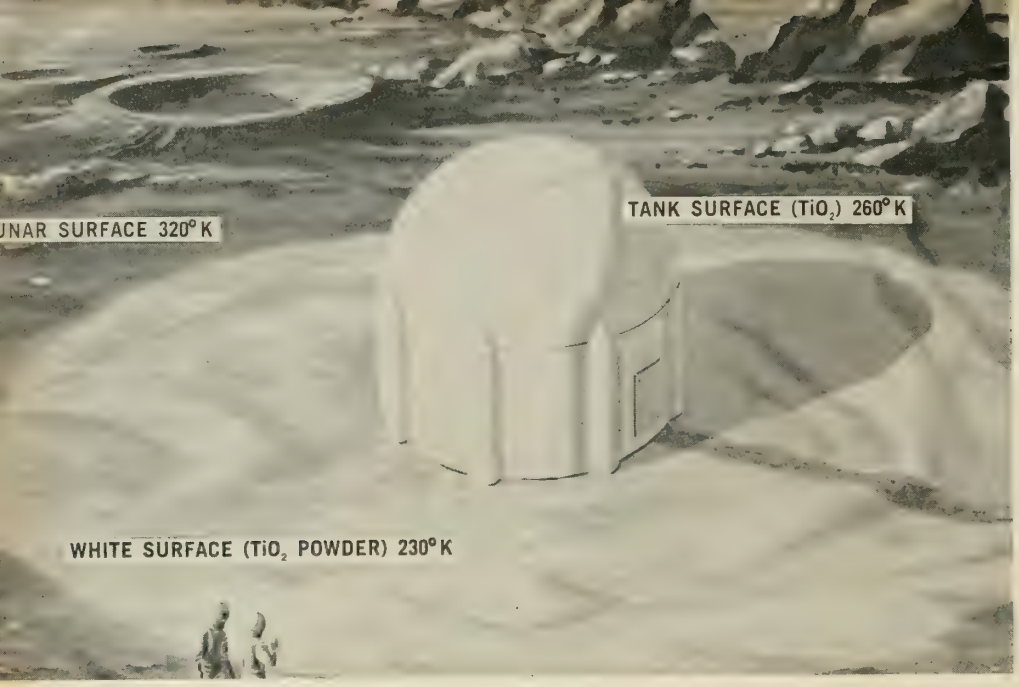
Noting that *Apollo* will grow into a lunar-exploration project, Lee revealed that NASA is working on a number of studies to find ways of deriving the maximum benefits once man sets foot on the Moon.

He pointed out that the big problem now is learning the nature of the Moon's environment. Without knowing this, NASA can not encourage anybody to draw up detailed engineering plans of Moon bases. Nevertheless, he forecast a fast turnabout when *Ranger* and *Surveyor* successfully land on the Moon and transmit their findings to Earth.

• **Subcommittee tackles Moon**—A prime consultant on Moon matters to the Office of Manned Space Flight is the Lunar Sciences Subcommittee, formed five weeks ago under NASA's Office of Space Sciences.

Charged with working out the scientific details of lunar exploration and setting them into a recommended program, this subcommittee will devise scientific projects that can be carried out on the Moon by automatic equipment and by man.

One of the subcommittee members is Dr. Charles Sonnett, chief of sciences



LUNAR propellant storage facility according to a recent Marshall Space Flight Center study.

of the Lunar and Planetary Programs Office of the Office of Space Sciences, who says industry will come in for a heavy share of the lunar basing and geophysics work—even developing specialized lunar equipment such as explosively driven hammers for taking samples of the Moon from rocky sites.

Sonnett said the subcommittee's approach to the lunar exploration program includes observation of natural lunar phenomena, collection of lunar material, and emplacement of automatic equipment which will continue to operate from the lunar surface even after man departs.

He listed the subcommittee's primary scientific fields of interest: geology and geochemistry, geophysics, atmospheres, exobiology, fields and particles, solar physics, surface physics, classical astronomy and radio astronomy.

"We must look at all possible means for cutting down the time needed for exploration—I believe time will be at a premium," Sonnett said. "For this reason we must look at all types of fast-acting, time-saving devices."

The subcommittee has already begun to shape the manned lunar scientific program.

• **Marshall timetable**—The interest of Marshall Space Flight Center in lunar surface operations is in part similar to industry's: the lunar-base operations set up the requirements for spacecraft and boosters to carry cargo and personnel to and from the Moon, and for lunar orbital operations. Marshall also is in the business of developing and operating large launch-vehicle systems, some of which undoubtedly will be used to support man on the Moon.

The Future Projects Office at Marshall expects the facility to proceed according to this timetable:

—1950-1960. Decade of preparation.

—1961-1965. First manned satellites.

—1965-1970. First large manned space-stations.

—1967-1970. First manned lunar expedition.

—1970-1975. Lunar base construction.

—1970-1980. First manned planetary exploration.

To get data on lunar-base construction and operations, Marshall proposes to spend $400,000 in Fiscal 1963, and an additional $2.4 million in Fiscal 1964. About $½-million would be earmarked for studies of possible lunar propellant-storage facilities and propellant-production facilities.

• **Military on the Moon** — The Army and the Air Force have sponsored several highly classified studies related to establishing bases on the Moon. In the main, these have been concerned with how a potential enemy could use a lunar base.

The Defense Department considers premature any studies beyond these; so far only civilians have an official lunar mission.

The Geophysics Research Directorate (GRD) of AFCRL is, nevertheless, vigorously studying the Moon to find out if the Air Force might indeed have a lunar mission. And the scientific work, headed by Dr. John W. Salisbury, chief of the lunar planetary exploration branch, appears to be based on substantial projects—in-house and contracted.

GRD is trying to build up a strong in-house capability. Even so, Salisbury told M/R that "we are eager to give contracts to industry on the basis of their unique ideas." GRD is now budgeted at an annual rate of $1.4 million

Marshall Space Flight Center Proposed Funding for Projects in Lunar Base-Construction and Operation

(×$100,000)

	FY 63	FY 64
Systems Requirements and Integration	200	300
Mark 1, Lunar Shelter Compatible with C-5, for First Apollo Crew	100	100
Lunar Scientific Station and Housing Complex	—	200
Lunar Power Facilities	—	200
Communication Facilities	—	200
Lunar Workshop and Storage Facilities	—	200
Lunar Surface Personnel Carrier	—	200
Lunar Base Construction and Utility Vehicle	100	100
Propellant Storage Facilities	—	200
Propellant Production Facilities	—	300
Food Production Facilities	—	200
Lunar Launch Facilities	—	200
	400	2400

for contracted lunar and planetary research.

Salisbury said that in September, 1959, the American Science & Engineering Corp. of Cambridge, Mass., came to GRD with the idea of determining the elemental composition of the Moon by examining the X-ray fluorescence caused by the solar bombardment of the lunar surface. The idea was so good, said Salisbury, that GRD has been funding the project ever since. "We are on the lookout for more ideas like this."

He said GRD's work is divided into observational, laboratory simulation, and theoretical studies. In turn, the observational studies are divided into ground-based, balloon-borne and rocket-borne.

• **Lunar research program**—GRD's program for observing the Moon from Earth puts major emphasis on spectroscopic and photographic studies in the visible region of the spectrum. Some recent highlights of GRD-sponsored research:

—A cooperative program with Aeronautical Systems Division, where the electro-optical techniques of image intensification developed by the missile-tracking group will be applied to lunar and planetary photography. Such image intensification would make it possible to take faster pictures of the Moon, thereby avoiding some of the "boiling" effect of the atmosphere. Salisbury estimates that this will yield about an order-of-magnitude increase in photographic resolution of the lunar surface.

—Volume II of the *Lunar Atlas*—considered to be the best collection of lunar photographs available—published earlier this year by Dr. G. P. Kuiper of the University of Arizona.

—A new 43-in. reflecting telescope bought for Pic du Midi Observatory in France. This facility is reputed to have the best "seeing" in the world; it is hoped that the new telescope will get photographs of the Moon and planets superior to any yet taken.

—Continuing efforts to set up the first Air Force observatory, possibly in the Sacramento Mountains of New Mexico. AFCRL already has a solar observatory in the same region.

—The discovery by investigators at the University of Manchester, England, using a newly built, high-resolution scanning spectrometer, of luminescing segments of the Moon. This confirmed earlier findings of N. A. Kozyrev and Du Bois.

• **Using balloons and rockets**—Under project *Sky Top*, a balloon is scheduled to be launched this winter carrying instruments to determine the distribution of lunar nighttime temperatures. Although the nighttime temperature of the Moon is usually said to be about −150°C, this figure may be as much as 50°C in error. Salisbury expects that under the current project, the error will be brought to within 5°C.

The work of the American Science and Engineering Corp., referred to earlier in this article, will be continued. An X-ray flux counter was flown aboard an *Aerobee* last October and, despite malfunction, detected X-rays from the Moon. The experiment will shortly be repeated, to define the intensity of the X-ray flux more adequately.

The ultraviolet reflection spectrum of the lunar surface is expected to give information about the mineralogical composition of the lunar-surface materials. To help get this information, Frederick Wilshusen of the University of Colorado developed a lunar pointer suitable for flight aboard an *Aerobee;* an ultraviolet camera being developed for use with this pointer employs a filter system to obtain photographs of the Moon in different regions of the ultraviolet spectrum. First flight of the system is scheduled for next January.

• **Using simulators and theory**—The environment of the Moon drastically affects the spectral responses of the body's surface materials. The infrared reflection spectra of solid materials, for instance, are affected by both the radiation environment and particle size. This makes it necessary to get laboratory spectra of probable lunar-surface materials in simulated environments, to compare with spectral data obtained from balloons and rockets.

For this purpose, a very low-pressure simulation chamber was ordered. Built by Ilikon Corp. of Natick, Mass., and enclosing a volume 18 in. in diameter and 34 in. long, it is expected to reach $2x10^{-10}$ torr. Scheduled to be delivered at the end of this month, it will provide three radiation inputs plus the visible: ultraviolet, X-ray, and alpha particles from a polonium source.

Main object of GRD's theoretical studies in the lunar sciences is to integrate data obtained from the ground, balloon and rocket spectroscopic studies with the results of simulation work.

Another program now in progress calls for statistical studies of the lunar surface—based on photographic evidence—in an effort to predict the lunar microtopography.

• **The Army and the Moon**—The Army Corps of Engineers wants to build a lunar-construction research facility in which a small piece of the Moon and its environment would be simulated in a large environmental chamber where construction and habitation activities could be rehearsed. The object would be to foretell how men and materials would stand up during the performance of practical works on the Moon.

Since the middle of 1960, when Army chiefs first presented the idea for such a facility to Congress, the service has taken the stand that the Army could not do much of a practical nature about the Moon until the facility is operating.

The Army estimates that the facility's detailed design will cost over a million dollars, and its construction about $6 million. The latter figure does not include the cost of special instrumentation and research apparatus.

The service is pushing to get construction money for the facility. Its preliminary design is to be completed by mid-summer, according to Harry N. Lowe, Jr., who heads up the Army's Moon-simulator program.

Lowe told M/R that if the program is approved and funded an engineering-architectural firm will be selected to do the detailed design. Subsequently, the facility would be built by the low bidder on a lump-sum contract.

Lowe estimated that the design phase will take about nine months to complete, and construction about two years. This means that if the go-ahead is given the Army simulator should be operating in late 1965 or early 1966—about two years before NASA expects to put a man on the Moon. ⁂

Selected Reading List on the Lunar Environment and Lunar-Base Construction

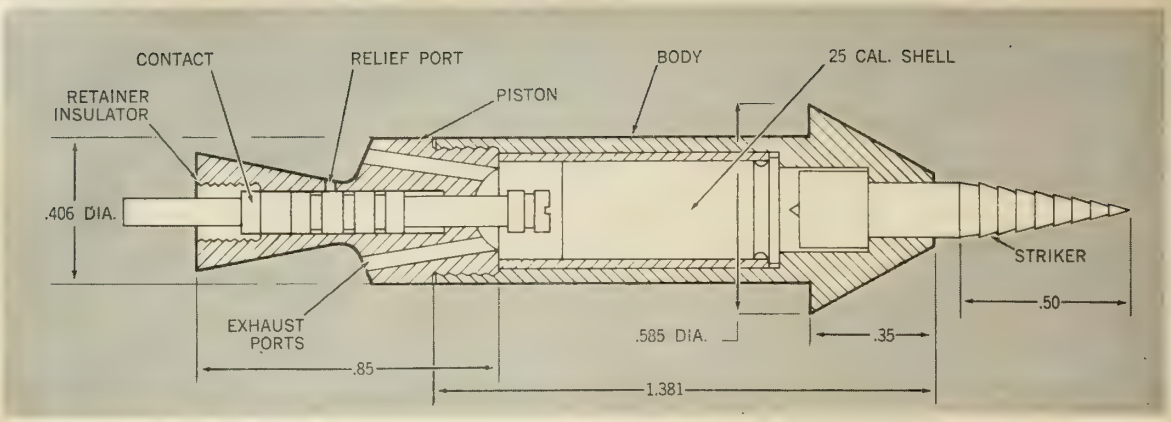
1. **"The Role of Geology in Lunar Exploration,"** by Jack Green and Jack R. Van Lopik, a section in *Space Science and Technology,* vol. 3, 1961, Academic Press, New York.

2. **"Engineer Special Study of the Surface of the Moon,"** by Robert J. Hackman and Arnold C. Mason, Map I-351, 1961, U.S. Geological Survey, Wash. 25, D.C., $1.50.

3. **"Location of a Lunar Base,"** by John W. Salisbury and Charles F. Campen, Jr., GRD Research Note No. 70 (or AFCRL Report No. 870), October, 1961, obtainable either from ASTIA, Arlington Hall Station, Arlington 12, Va., or from U.S. Dept. of Commerce, Office of Technical Services, Wash. 25, D.C.

4. **"Exploration of the Moon's Surface,"** by Eugene M. Shoemaker, *American Scientist,* vol. 50, no. 1, March, 1962.

5. **"Proceedings of Lunar and Planetary Exploration Colloquium,"** a series of publications edited for the colloquium by E. M. Fallone, Dept. 429-05, Space & Information Systems Div., North American Aviation, Inc., 12214 Lakewood Blvd., Downey, Calif.



LUNAR VEHICLE stabilization could be achieved with this imbedment anchor. A small charge within the unit provides added impetus and actuates the line brake and snubber mechanisms. This is one of four landing concepts studied.

SPECIAL REPORT . . .

Shock Mitigation Systems Analyzed

Dynamic scale-modeling at Pneumodynamics provides effective tool for study of lunar landing

by John F. Judge

THE MULTIBILLION-DOLLAR effort to put man on the Moon will actually take him to within a relatively small distance—some two to 60 feet—of the lunar surface.

After reaching this point of zero velocity, the astronauts will depend exclusively on some sort of shock mitigation system. At best, they can expect a bone-jarring landing. Otherwise, there will be varying degrees of vehicle damage on impact—at worst, total destruction.

The retro-system will, of course, have performed the main deceleration job—any landing system will be designed to augment rather than replace retro-rocket capabilities. But impact absorption systems must fill the gap between zero velocity and actual landing.

The evolution of the aircraft carried with it a comparable advance in the technology of landing systems. All previous systems, however, were based on the existence of an atmosphere—a factor lacking in the lunar environment. Since it is probably impossible to design a perfect retro-system, some form of impact absorption must be an integral part of any manned lunar-landing vehicle—and also of several unmanned probes, such as *Surveyor*.

• **Seeking the optimum**—The Instrumentation and Controls Division of Pneumodynamics Corp. investigated, under Air Force sponsorship, a number of lunar-landing concepts. The study pointed to the need for developing shock-mitigation equipment in parallel with all other work on advanced flight vehicles. Researchers found that for every vehicle and mission, there is an optimum shock-mitigation system.

This optimum depends on:

—Basic vehicle configuration including center of gravity.

—Mass distribution of the vehicle.

—Allowable mass for shock-mitigation and repeatability requirements.

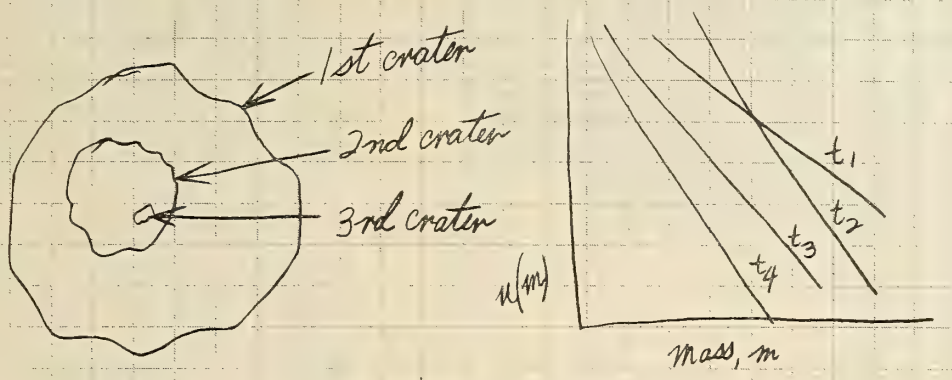
—Landing dynamics and the surface characteristics to be encountered.

The program demonstrated that mass ratios for shock-mitigation equipment versus the overall mass of the vehicle can be derived through analytical studies and tests with dynamic models.

Initially, the whole of Pneumodynamics Corp.—then Cleveland Pneumatic Industries, Inc.—contributed, in order to present the maximum number of concepts. Of the ensuing 100 ideas, cursory analysis by the firm and Wright Field engineers eliminated 50 of the less promising.

Wright Field engineers selected the 16 most promising and subjected these to an intensive analysis—reducing the total number of concepts to 4. Detailed design was then initiated to show feasibility through the use of dynamic scaling model techniques. Precise mathematical models were derived.

• **Industry surveyed** — A basic framework of parameters was established by extrapolating known shock-mitigation levels. Information was



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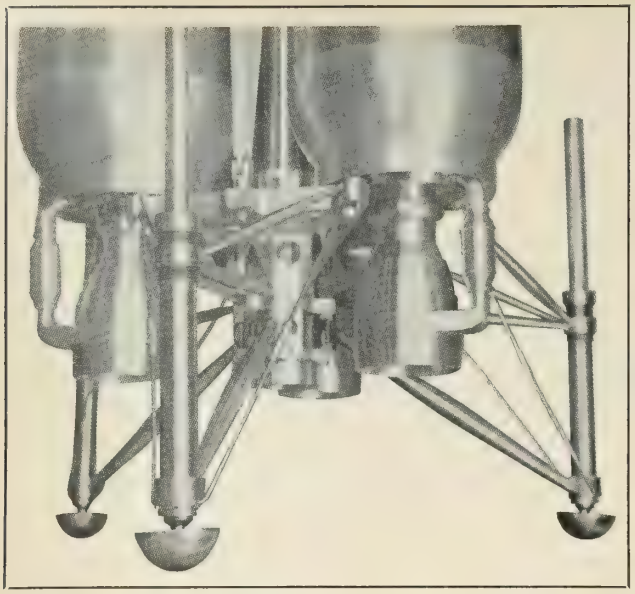
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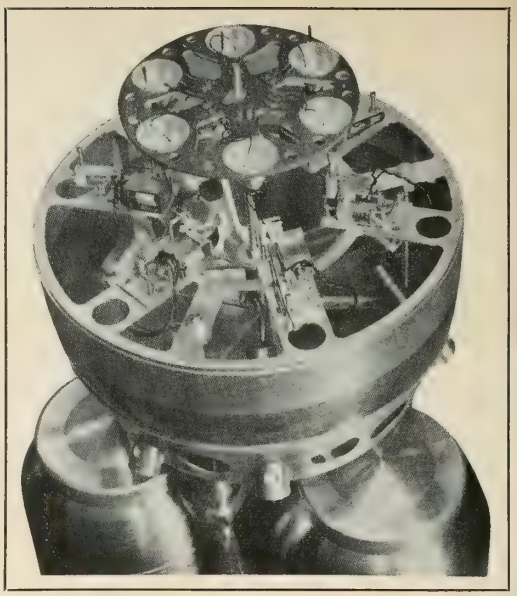
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IMBEDMENT anchor system mounted in the model vehicle illustrates the internal system configuration.



TRI-COLLAPSIBLE outrigger with struts in collapsed position. Frangible rings absorb landing shock.

gathered from airframe manufacturers.

Landing gear in modern fighters and transports can withstand vertical impact velocities up to approximately 20 and 14 ft./sec. respectively; horizontal touchdown ranges from 80 to over 160 mph. Vertical decelerations are handled up to about 12 g's, and horizontal decelerations up to several g's.

The vertical component of the landing impact force is traditionally mitigated by use of rigid air-oil (oleo) struts; the horizontal by aerodynamic drag, rolling friction, wheel brakes, etc.

Aerodynamic drag is non-existent on the Moon, and landing fields are in the same category. The Air Force called out other assumptions: the operations are "manned" only, return capability is included, with an impact of 4 g's (128.8 ft./sec.^{2}) with an ultimate of 6 g's (193.2 ft./sec.^{2}). All of this came from a survey of the aerospace industry.

In general, the criteria for formulating lunar landing concepts covered:

—Safe deceleration of 4 Earth g's maximum.

—A 1.5 safety factor applied to deceleration.

—A retro-thrust capability sufficient to limit descent to 35 ft./sec. maximum safety vertical impact velocity (42.8 ft./sec.) ultimate.

—Horizontal velocity of 10% vertical.

—Vehicle axis 10° maximum out-of-parallelism with local vertical.

—System to be manned, with a return capability.

—Based on the man and returnability aspects, a vehicle gross weight at impact of 20 tons (Earth)

Consideration was given to launch-assist capabilities in the shock-mitigation system.

The four final concepts included:

—Triple vertical collapsing strut employing frangible rings.

—Oleo pogo for alightment and departure.

—Inbedment anchor for stabilization during and after alightment.

—Triple oleo outrigger for alightment.

• **Concept testing** — Immediately following concept selection, dynamic scale ratios and physical quantities describing the concepts and test-bed vehicles were selected in concert with Wright Field engineers. Essentially, the test-bed model built by I&C is a physical analog of hypothetical full-scale lunar prototype systems.

The basic test-bed vehicle was configured in such a manner as to accommodate hardware for each of the selected landing concepts, with only minor qualifications.

Kinematic scaling was primarily employed in the model, and the configuration was arbitrarily selected from the current state-of-the-art. Dimensions and overall radii of gyration were maintained in the selected length ratio of 10:1. Densities of materials were maintained in the ratio of 0.605:1, moduli —1:1, and centers of mass were kept proportional.

This precautionary approach kept the choice of materials nearly the same in the test model as in the prototype.

For concept testing, engineers built a test-bed system predicated on a structure/propellant ratio of 40:60, using

Table of Prototype-Model Quantities

	PROTOTYPE		MODEL	
1. Length (approx.)	L	42 ft. 6 in.	l	4 ft. 3 in.
2. Earth weight	W	45,375 lb.	w	75 lb.
3. Mass	M	1407 slugs	m	2.33 slugs
4. Gravity acceleration	G	5.32 ft/sec^2	g	32.2 ft/sec^2
5. Max. safe impact velocity	V	35 ft/sec	v	27.2 ft/sec
6. Max. safe deceleration	A	128.8 ft/sec^2	a	780 ft/sec^2
7. Deceleration safety factor		1.5		1.5
8. Ultimate deceleration	*A_1	193.2 ft/sec^2	a_1	1169 ft/sec^2
9. Oleo pogo stroke length (69% eff)	H_o	67.87 ft.	h_o	8.25 in.
10. Collapsible pogo stroke length	H_c	4.75 ft.	h_c	5.7 in.
11. Impact velocity needed to achieve ultimate deceleration A_1	V_1	42.8 ft/sec	v_1	33.4 ft/sec
12. Safe impact force	F	188,900 lb.	F	1889 lb.
13. Ultimate impact force	F_1	279,280 lb.	f_1	2792.8 lb.
14. Oleo spring rate F_1/H_o	K_o	40,652 lb/ft	k_o	339 lb/in
15. Collapsible spring rate F_1/H_c	K_c	58,750 lb/ft	k_c	490 lb/in
16. Free drop time for ultimate load	T_1	8.05 sec.	t_1	1.005 sec.
17. Free drop height for ultimate load	S_1	172.5 ft.	s_1	17.25 ft.
18. Kinetic energy at ultimate impact	E_1	1,294,000	ε_1	1294 ft. lb

* Subscript '1' refers to ultimate load.

H_2 and O_2 with a foreseeable reliable I_{sp} rating of 300 sec.

This ratio was assumed to exist at touchdown, as was zero velocity at an altitude of 60±55 ft. above the lunar surface. Free fall would exist from this point to the surface. The retro-tanks were assumed to have been jettisoned at the point of zero velocity. Their mass would not be included in the system's touchdown mass.

• **Tri-collapsible outrigger** — The principle of absorbing landing shock with frangible rings involves the absorption of impact energy as a non-repeatable operation. The method is to circularly rupture a stack of rings of reliably predictable tension yields by forcing them over a cone.

Testing the triple vertical configuration showed that a slight jamming of the rings during fracturing caused the strut to impose a greatly magnified impact force to the strut extension members—and that this occurred instantaneously.

This caused the extension structure to collapse due to the shortened effective stroke length. Although the extension members were stressed for a full 11.5-ft. drop, they failed when much greater load was applied. I&C suspects shock-wave phenomena in this failure.

The frangible concept has several advantageous characteristics—it is simple, economical, and relatively insensitive to temperature variations and other aspects of the space environment. It also has a 100% efficiency of strut action and complete self-stabilization.

A single-strut, frangible ring pogo evolved as a sub-concept from the tri-collapsible outrigger. Preliminary tests were successful—its mass ratio is the lowest of all concepts tested, only 0.84% of total—but an additional system is needed for stabilization. With anchor stabilization, the total mass ratio moves up to 2.33%.

The determination of optimum frangible ring dimensions for this sub-concept imposed the same problems as the outrigger, but fewer parts were involved.

Departure capability was included by fitting a 12.5-cu.-in. high-pressure vessel to the upper end of the pogo cylinder. Theoretically, this system could impart an upward velocity to the model test bed, lifting it about 50 ft.

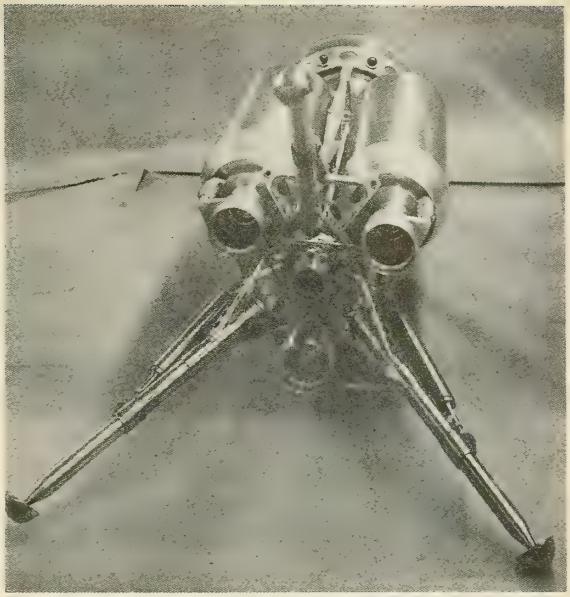
I&C experts considered three imbedment anchors, each 120° apart, adequate for vehicle stabilization. This includes simultaneous imbedding and the maintaining of proper tension on the lines.

Requirements for this system included simultaneous firing. In addition, the lines had to be prevented from feeding-out after anchor contact, and then tensioned.

Finally, the system had to be capable of operation and hold on irregular surfaces of varying compressibilities.

Each anchor line has two miniature insulated conducting wires leading to the solenoid. The power source consists of 3 sets of three 9-volt dry cells in series/parallel (27 volts to each solenoid).

The batteries were distributed evenly among each of the three fuel tanks comprising the LOX mass. This maintained the centers of gravity and radii of gyration for each tank.



TRIPLE-OLEO Outrigger with extended struts. Upper piston is an air-oil system, lower strut is telescopic.

The anchors are spring-released inertially on model impact. As each anchor strikes the surface, a 25-cal. primer and several grains of powder ignite. The gases generated are contained in the anchor body and jetted from its tail-end.

Within the anchor itself, the high-pressure gas closes a switch, completing the circuit to the line-brake and snubber. The operation also provides extra impulse to the imbedding anchors.

The entire sequence took 25 milliseconds with the models. I&C designers scaled the anchor system primarily for similitude of kinematics, forces and restraints—since these quantities were more important in concept testing than anchor geometry.

• **Oleo pogo** — This concept involves known landing gear principles—an air-oil system in which hydraulic fluid is forced between an orifice and a moving metering pin when impact force is applied to the pin-piston assembly.

I&C had very successful preliminary tests with this system. While its weight is somewhat greater than the frangible-ring pogo, its load-absorbing ability is predictable and it can be used repeatedly.

Departure capabilities involve the same pressure vessel addition as the frangible-ring pogo. Theoretically, the pressure bottle adapted to the oleo pogo could fire the test bed to an altitude of 40 Earth feet. This represents a figure in excess of 400 lunar feet—a considerable launch assist.

In the triple-oleo outrigger concept, most of the impact force is absorbed by the upper, or oleo, piston. The lower strut is telescopic and provides for the spreading tendency of the feet during alightment. The feet will retract in landing on surfaces with a friction coefficient of approximately 0.3 or more—or if there are obstacles.

While the weight of this particular concept is greater than any of the others, comprehensive testing should provide methods of reducing this to an acceptable percentage of total mass.

• **Structural considerations** — I&C specialists point out that although the times and forces involved in deceleration during shock mitigation are easily figured by formula, the really critical quantities in complex systems are not so readily computed. Failure in a beam or structure sometimes occurs at load values quite different from those derived through routine calculation.

One instance of this is the existence of interacting shock waves in structures undergoing suddenly applied loads. The reproduction of these shock waves in test models means matching prototype to model extremely closely in the ratios of moduli and densities. When this is done, the same materials can be used in the model and a scale time history of motions and shock waves preserved.

Man's presence introduces even more complex problems. The critical change in velocity causing at least mild shock in man is 80 ft./sec.—but proper anti-g devices can increase this tolerance.

The impact of lunar alightment would be hundredths of a second in duration. Orbital rendezvous, on the other hand, could impose severe velocity changes for longer durations during thrust maneuvering and grappling. ⌗

Soviets Indicate Lunar Landing Set For 1965

RUSSIAN SCIENTISTS are recommending a manned lunar landing program which almost duplicates America's Project *Apollo*.

There is one major difference. The Soviets strongly imply they will land on the Moon by 1965. The 1966-70 period, they declare, will be unsafe for manned space flight because of heavy solar flare activity.

The Soviet program, however, includes plans for *Ranger, Surveyor* and *Prospector* type spacecraft for exploration of the Moon and manned circumlunar flights to precede the manned lunar landing.

The Russian space experts are also perplexed by a problem still confronting their American counterparts—should direct flight or orbital rendezvous be used for manned flights to the Moon and planets?

These and other details of the Russian space program are revealed in a U.S. Commerce Department translation of Soviet technical papers.

There is no indication whether the scientific recommendations have gotten the official Kremlin seal of approval. All six of the papers quoted, however, call for roughly the same program, indicating a unanimity of opinion in Soviet scientific circles.

Some of the Soviet plans revealed by the scientists included:

• **Scientific exploration of the Moon**—Additional flights with scientific spacecraft must be made around the Moon to take detailed photographs of its surface. Then a lunar softlanding spacecraft should be used to send back data on the structure and composition of the lunar surface. Television cameras would be used to send back views of the landscape. Another spacecraft would then gather and bring back to Earth samples of the lunar surface. This program closely approximates the U.S. unmanned lunar exploration program which includes the *Ranger, Surveyor* and *Prospector* spacecrafts.

• **Manned space flights** — Further manned flights into space—with gradually increased duration—are necessary. Circumlunar flights should precede the manned lunar landing. It is probable that the manned flights to the Moon will overlap the unmanned scientific spacecraft flights. The manned flights would not be made in the 1966-70 period because of heavy solar flare activity. This indicates that the Russians plan to land a man on the Moon by 1965 or not until after 1970. After the lunar landing, a scientific research station would be established. This would serve as way stations for space flights to Mars, Venus and other planets.

• **Communications** — Information from the unmanned lunar spacecraft will be relayed to Earth via stationary Earth satellites.

• **Lunar landing sites** — The best landing site for the manned Moon voyage is in the middle latitudes on the visible side. The "seas" would offer the most suitable site, but they are very distant from the more interesting craters. The Equatorial zone is too hot and a landing on the reverse side is excluded because radio communication with the Earth is impossible.

• **Lunar maps** — When the time comes for the first cosmonauts to land, detailed maps of the lunar surface will be available. Astronomers are now working hard on the problem and there is now no feature over 50 miles in diameter on the visible side of the Moon which has not been mapped.

• **Interplanetary manned spaceflight** —Manned Spacecraft for flights to the Moon, Mars and Venus should have an initial launching weight, from an Earth satellite orbit, of several hundred to several thousand tons. To solve the weight problem, Soviet scientists are considering the assembly of interplanetary ships in an Earth satellite orbit by using rockets to fit various sections. Electric, ion and plasma engines will also have to be developed for interplanetary flight. ⌘

Russians Credit Automation With Saving Lives

IN SPITE OF U.S. findings that man may well be the most important part of a spaceship control system, the Soviets hold automation responsible for the fact that "not a single life has been lost in the space effort."

"Man is incapable of reacting rapidly enough to emergency situations such as an impending collision with a meteorite," Russian space engineer T. Mashkevich wrote in a recent article.

She disclosed that the Soviets are considering powerful quantum generators which would operate in virtually the entire range of electro-magnetic wavelengths.

These generators, she said, will create powerful light beams of great density and exerting enormous pressure. The beams would be directed ahead of the spaceship, sweeping away any meteorites and transforming them into "mere dust."

However, she conceded that, in the long run, human intellect and sensations are the only forces capable of learning the secrets of the universe.

• **Titov revisited**—*A research institute official interviewed in Moscow said that the question is still open whether "Titov's sickness" can be expected in all cases of weightlessness, or whether it was an individual peculiarity of Titov's organism. (Russian space medicine officials told COSPAR that other animals, including dogs, had suffered the same effects after about 6 orbits.)*

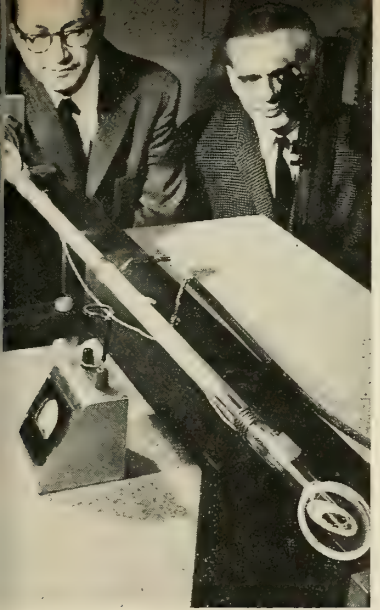
The Soviet official, N. N. Gurovskiy, expressed the Soviet's concern over the problem. He said that the influence of weightlessness on the otoliths may be a possible explanation of these disturbances. (M/R, May 7, 1962).

"With a change in gravity or with turning of the head, the pressure of the otoliths (one of the organs of the inner ear affecting balance) on the nerve endings changes," he explained. These nerve signals are transmitted to the central nervous system. Under a state of weightlessness the otoliths lose their weight and can no longer exert pressure on the nerve endings. The automatic nervous system which regulates such functions as digestion, sweating, cardiac activity, etc., is affected."

The Soviets said that Lt. Col. John H. Glenn did not experience the sensation because of his shorter trip. They added that the incorporation of a gravity field in the spaceship might be necessary as an answer to the sickness problem. They said it need only be one-quarter or one-tenth of that at the Earth's surface, although the exact value has not yet been determined.

• **Junior birdmen**—*The disparity in ages between Soviet and U.S. astronauts was explained by the Soviet official:*

"We consider space flight to be a profession; cosmonauts should have a future in this field and therefore be young. If cosmonauts are not to devote their lives to this field, the age factor is less important." ⌘



GENERAL TELEPHONE and Electronics Corp. continuous-wave laser shown at AFCEA.

Sole-Source Procurement Blamed on Poor Planning

Navy Materiel chief addresses one of four panels at AFCEA meeting; over 5000 attend annual conference

by Charles D. LaFond

TOO MANY sole-source procurements by the Department of Defense are due to improper advance planning, failure to enforce contractual technical provisions, and an acceptance of the sole-source buy as the easiest and most convenient method of contracting, says Rear Admiral Herschel J. Goldberg.

Speaking last week before a panel at the 16th Annual Armed Forces Communications and Electronics Association (AFCEA) convention and exhibition in Washington, D.C. the vice chief of naval materiel cited four ways in which DOD can achieve a better return on its investment in industry:

(1) increase competition

(2) better administer and monitor contractor performance

(3) more timely and better dissemination of technical data

(4) better breakout of major subsystems from primes.

In summary, Goldberg asserted that industry no longer will be given the responsibility of self-control over contract performance. Rather, the military will shift its emphasis from item-by-item product and voucher review to a continual inspection of contractors quality and cost control systems.

In addition, said Goldberg, the military will continue to tighten its enforcement of contract provisions including delivery schedules.

Finally, he asserted, since 50% of DOD dollars flow through prime contractors' purchasing systems, the government is going to steadily increase its surveillance of prime contractor policies and procedures with respect to subcontractors.

• **AFCEA still growing**—Already the largest technical meeting of its kind held annually in Washington, AFCEA managed to surmount the current trend in industry of minimizing conference support and continued to grow again this year. Attendance exceeded last year's 4500 by almost one thousand.

The only thing restricting the convention's more than one hundred exhibitors (providing 180 separate displays) was the limited exhibit area.

Highlighted during the 3-day meeting were four panels:

—"Modern Trends in Data Communications," chaired by T. F. McMains, V.P. of Western Union and discussed by W.U. representatives.

—"Command and Control for Survival," monitored by J. J. Connolly, V.P. and general manager of Data Systems Division and discussed by Litton Industries scientists.

—"The *Telstar* Satellite," moderated by C. M. Blair, V.P. of AT&T and presented by a group of Bell Telephone Labs and NASA spokesmen.

—"Getting More for the Defense Dollar," was discussed by a tri-service group directed by Maj. Gen. H. Scofield, U.S. Army.

• **Few critical weapons**—In summarizing the status of today's defense industy and DOD future requirements, key-note speaker Dr. Harold Brown, director of defense research and engineering, DOD, itemized the very few systems deemed truly critical to U.S. security. These included the nuclear and thermonuclear weapons, the first radars, ICBM's, the entire *Polaris* program (and he included the nuclear submarines).

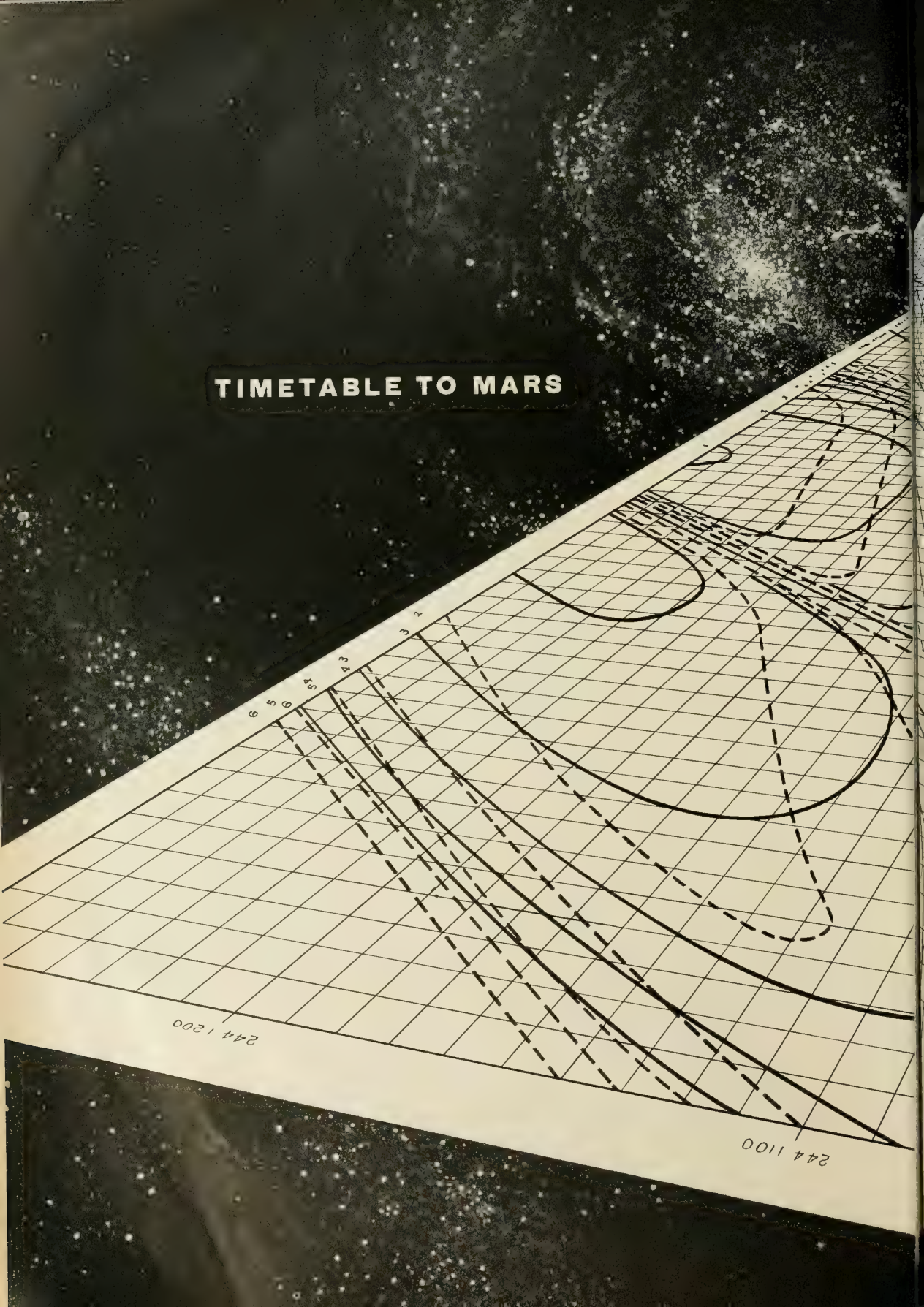
Two items for the future also were categorized by Brown as equally critical: an anti-ballistic-missile capability and the development of command and control systems.

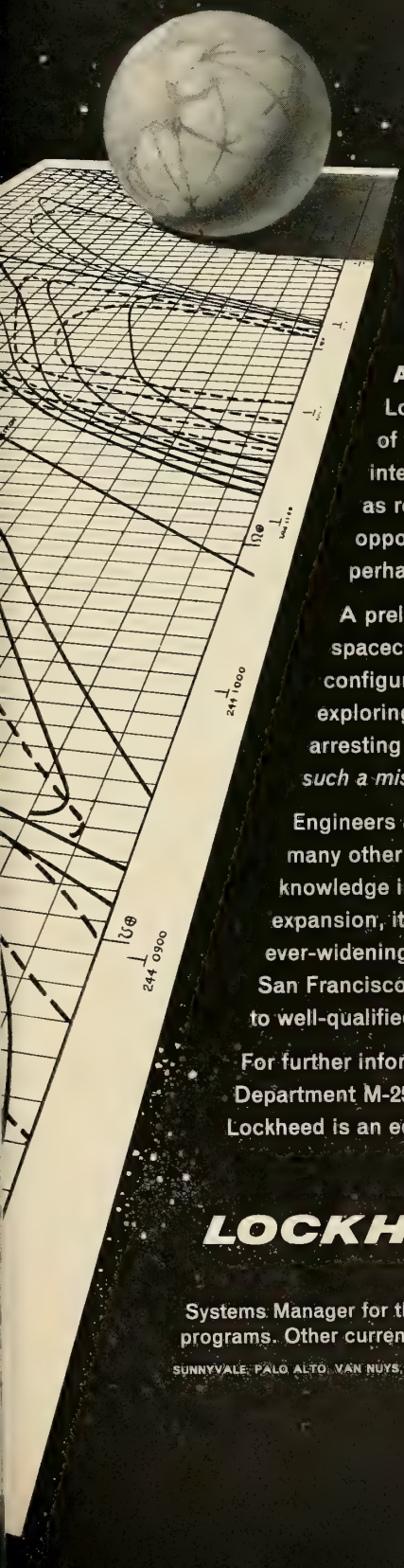
He stressed these areas as well as secondary developmental areas to indicate how DOD and his own RDT&E group must maintain certain contraints in funding programs. For example, the increase of $8 billion in the annual DOD budget shows that it is possible to increase military expenditures. However, before doubling the military budget it would be necessary to show that the corresponding capability was necessary for national security.

Additional capabilities may turn out to be of marginal utility, he said. Specifically, in R&D, a 40% increase in expenditures could not be accompanied by a corresponding increase in the availability of either capable technical people or militarily useful systems. In electronics alone, he declared, defense R&D already accounts for the applications of from 70-80% of the nation's entire resources.

A solution to some of the problems experienced by government in the evaluation and selection of new programs might be evolved, said Brown, by expanding the partnership of government and industry.

Generally, he maintained, government reviewers can tell the difference between good and bad proposals. The trouble is that people higher up the chain of command don't aways know the difference between good and undesirable programs. ⌗


TIMETABLE TO MARS
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Arrive Mars: 10.3 August, 1971 Giant steps were taken recently at Lockheed Missiles & Space Company toward manned exploration of the planets Mars and Venus. For the first time, accurate interplanetary transfer orbits have been plotted to show velocities as related to departure and arrival dates for an entire cycle of planet oppositions. A "fast" round-trip would take a year, allowing perhaps ten days exploration time on Mars.

A preliminary but comprehensive study also was made on the spacecraft's design considerations. Many facets were explored—configuration, single versus multi-stages, weight, thrust, payload, exploring, landing, and return equipment; and many more. The arresting conclusion of Lockheed scientists: *A vehicle can perform such a mission within the present state-of-the-art.*

Engineers and scientists at Lockheed Missiles & Space Company conduct many other feasibility and research studies, probing for advanced knowledge in a wide diversity of disciplines. Lockheed's constant expansion, its growing leadership in missiles and space, its ever-widening scope of projects, its ideal location on the beautiful San Francisco Peninsula—all open new and unusual challenges to well-qualified people.

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Site decision nears . . .

N.Y. May Get Nuclear Test Facility

Advanced pulse reactor could halt cross-country flow of gear for radiation testing

by Michael Getler

NEW YORK—A decision should be forthcoming next month on the establishment of a nuclear test and research facility in New York State.

If approved, the test center, according to officials in the state Office of Atomic Development, would house the only advanced-type pulse nuclear reactor in the northeastern U.S.—and the only one in the country outside the national laboratories.

Locating a high-power pulse reactor in this area would be a potential boon to the heavy concentration of electronic systems and component manufacturers in the Northeast whose equipment, bound for missile and space systems, must now be transported cross-country for radiation tests at Sandia Corp.'s "Godiva" reactor at Albuquerque, N.M. At present, the Sandia reactor is said to be the closest one available for industry use.

State officials point out that setting up a center in New York for this type of testing would slash user firms' transport costs, eliminate much inconvenience, and reduce the time that personnel of the parent company must spend accompanying the test equipment to New Mexico. It would also generally enhance the competitive position of the Northeast for future business.

Another big plus, industry spokesmen in this area assert, would be the availability of a local facility for testing commercial and company proprietary developments in addition to contracted defense items.

• **Room for growth** — Actually, state planners envision eventual expansion of the facility into a complete space technology and atomic radiation center. The initial plant would house the primary piece of equipment—an advanced pulse reactor. Eventually, however, the state hopes to add other equipment not generally available here including a proton accelerator, a flash X-ray machine, and a very-high-intensity beta-ray source.

The move to establish a nuclear test center in New York got under way in 1960, but the real impetus came last January, when the Office of Atomic Development awarded a $15,000 contract to Galson and Galson, Inc., Syracuse, N.Y., consulting engineers, for a feasibility study of establishment of a pulse reactor facility. Putting up the money for this study were five major firms in this area—Bell Telephone Laboratories, Inc., General Electric Co., General Precision, Inc., Grumman Aircraft Engineering Corp., and International Business Machines, Inc.

Each of these companies, invited with several other firms to an earlier meeting called by the state, showed an interest in having this type of reactor nearby. Each of the firms is also a major supplier of missile/space hardware to NASA and other government agencies; information on transient radiation effects on airborne radar, navigation, guidance and control equipment, either from a weapon burst or solar activity, is vital to them.

The Galson and Galson study is now complete and in the hands of both the state and the sponsoring firms.

New York State officials are reported ready to go along with the study recommendations. The industry representatives are expected to make known their feelings in about a month.

• **Advanced discussions** — Though details are being closely guarded at this point, the study is known to have recommended, with some alternatives, means for organization, financing, equipment selection, management, and eventual expansion. The sites under consideration reportedly have been narrowed to four, with state officials now meeting with AEC representatives to discuss the distance requirements for locating facilities of this type.

Just who would run the facility is also not yet clear. Based on past experience and a desire to meet all the criteria of impartiality in management, there is a strong possibility that a site near a university will be chosen, with an experienced university team running the project. This, however, is not the only course under consideration.

Last month, the state allocated $800,000 for construction of initial facilities. The plan is to have industry buy the equipment which will go into it, with the state acting as a "sympathetic landlord." To put in the type of reactor which is envisioned would probably cost an equivalent amount, making the overall cost of setting up this initial facility about $1.5 to 2 million, according to state estimates. The facility could be operational between 18 and 24 months from the time of go-ahead.

In addition to the five firms which sponsored the study, and other New York companies, state officials report there is strong interest in the center among industry firms in New Jersey, Connecticut, and Massachusetts. The plan is that in the future these firms also will be brought into the picture, as sponsors and/or users.

Interest is also reportedly high at Ft. Monmouth, N.J. where the Army Signal Corps R&D center is located.

• **Choice of reactors**—The type of reactor which goes into the facility will be determined by the study recommendation in conjunction with the industrial requirements and the economics of achieving the desired power levels.

Three types of pulse reactors are known to be under study—The "Super Godiva" or Health Physics Research Reactor now in use at the Oak Ridge National Laboratory, a Super TRIGA Reactor, and a new device based on advanced specifications supplied by the Defense Atomic Support Agency (DASA) through Ft. Monmouth.

Of these, the "Super Godiva" type is reportedly attracting most attention. This reactor can reportedly achieve a peak power of 63,000 megawatts with a pulse half width duration of 38 microseconds. The "Godiva" reactor at Sandia is said to achieve 13,000 megawatts peak power with a pulse half width of 70 microseconds.

The Super TRIGA Reactor operates generally at lower peak power levels, though it has other advantageous features including a 500 Kw steady-state power capability.

The levels called out in the DASA specs for a mixed gamma-neutron source are described as considerably greater than those obtained to date with Godiva-type reactors.

The DASA specs call for a dose rate of 5×10^{18} neutrons/cm^2 sec., an integrated dose of 5×10^{14} neutrons/cm^2 sec., a pulse width variable from 10 microseconds to 1 millisecond, a repetition rate of at least one pulse per hour, and a peak power in excess of 63,000 mw.

The Industry Week

Industry Trends and Forecasts

Martin Co.'s Space Systems Division has cut the cost of the gyroscope for Bullpup's guidance system by nearly 75% through use of new manufacturing and design techniques. The new gyro, with only 16 major parts and six bearings, was developed by Martin over the past two years. It will be installed in Bullpup trainer missiles built under a recently-announced AF contract. . . . *The National Aeronautics and Space Administration has ordered four General Electric 225 computers to perform scientific and engineering data analysis on the design of the Saturn booster. Two have been installed at NASA's Space Flight Center, Huntsville, Alabama, and the other two are scheduled for installation within the next few weeks.* . . . General Electric Co. has reduced prices on its High Reliability foil tantalum capacitors on an average of 30%. The price decrease came after the Autonetics Div. of North American Aviation notified GE that the capacitors attained the ultimate reliability goal on the foil tantalum portion of the Minuteman program. . . . *The Boeing Co. placed more than $845 million in orders with suppliers and subcontractors during 1961. Of a total $845,604,383, some $489,700,000 was in connection with military programs. Of this total, California got the greatest amount, $154,251,000, with the company's home state of Washington second, $62,916,000, and New York third, $35,359,000.* . . . Delta Air Lines has applied to the Civil Aeronautics Board for permission to serve Huntsville, Ala. on the line's southern transcontinental route to Los Angeles via Dallas/Fort Worth. The company said the route would benefit personnel traveling between Huntsville and other space vehicle testing and launching sites in the Dallas/Ft. Worth area and along the West Coast.

International News Briefs

Micom Limited has been formed in Montreal, Quebec, as a wholly-owned subsidiary of Micom Inc. The company performs engineering, construction, installation and maintenance services for point-to-point communication systems and has a proprietary line of microwave towers and passive reflectors. . . . *Lijas Finas de Guadalajara S.A., a Mexican company which manufactures coated abrasives, is now part of the Norton Co. organization headquartered in Worcester, Mass.* . . . Ryan Aeronautical Co. and Compagnie Française Thomson-Houston signed a licensing agreement under which Ryan Doppler radar navigational equipment will be produced for the European market.

New Industry Facilities

North American Aviation, Inc., established a Basic Science Center to "concentrate on the scientific disciplines themselves and try to establish new understanding of phenomena and materials. Small groups of scientists will be organized around each of a number of such disciplines and they will explore the frontiers of knowledge and attempt to reach beyond." The Center will be headquartered in Canoga Park, Calif. . . . *Westinghouse Electric Corp. Baltimore Defense Center constructed a facility for R&D in underwater acoustics. It will be used initially for testing and calibration of underwater sound projectors and hydroplanes. The facility includes a small artificial lake with a floating lab moored in its center.* . . . Westinghouse also completed a research and development center near Pittsburgh to "expedite the development of new scientific knowledge and its translation into new products, processes, materials and systems." The lab will concentrate in two bread areas—materials science and technology, and equipment science and technology. . . . *Melcor Electronics Corp. is building a plant in Farmingdale, N.Y. The company's transistorized amplifiers and circuit modules are used in missile, navigational, guidance and ASW equipment.* . . . Intaspace Corp. will move to a new building in Kenilworth, N.J. The company manufactures rigid waveguide bends, transistions and twists for the microwave industry. . . . *General Motors Delco Radio Div. will open two new buildings—a 132,000-sq.-ft. research and engineering facility and a 225,000-sq.-ft. semiconductor manufacturing building—in Kokomo, Ind.* . . . Lawrence Aviation Industries, Inc., added two new buildings to its industrial complex in Port Jefferson Station, N.Y. The firm makes pressure vessels and plastic structures for the missile industry. . . . *Materials Testing Co., Inc., plans to build a new lab in Gaithersburg, Md., to house enlarged environmental and reliability testing facilities and a new aerospace elastomers research lab.* . . . The DeVilbiss Co. opened a new facility in Toledo, Ohio, to serve its Chicago direct factory branch. . . . *Philips Space Development has moved into a new building in Mt. Vernon, N.Y. Philips is part of the Norelco group and is devoted to research, development, feasibility studies and prototype engineering. The facility will be used for design and production of hardware for Project Surveyor.*

New Corporate Divisions

Westinghouse Electric Corp. established a Superconducting Materials Dept. at the Materials Manufacturing Division, Blairsville, Pa., to develop, manufacture and market superconducting materials. The department will be under the direction of Dr. Malcolm J. Fraser, former project leader of the High Strength Superconducting Materials Project. . . . *Thiokol Chemical Corp.'s Reaction Motors Div. set up a Theoretical Evaluation Service to provide rocket propellant manufacturers and subsystem suppliers with answers to specific-impulse problems.* . . . General Motors' Allison Division created a market planning section, to be headed by Roy M. Acker, formerly of GM's Defense Research Labs. The new section will develop long-range plans, prepare and maintain market intelligence, sales forecasts, market analysis and research on products and services. . . . *Geophysics Corp. of America formed an Atomic and Molecular Physics Dept.*



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contracts

AIR FORCE

$8,800,000—**Martin Marietta Corp.**, Baltimore, for activation of *Titan* missile bases in the West.

$7,344,060—**American Air Filter Co.**, St. Louis, for manufacture of temperature control systems for the *Minuteman* missile base at Ellsworth AFB, S.D.

$7,219,000—**International Telephone and Telegraph Co.**, for electronic command and control equipment at Paramus, N.J.

$6,984,000—**General Motors Corp.**, for guidance equipment for *Titan II* missiles. Work to be done at Milwaukee.

$5,176,300—**North American Aviation, Inc.**, Downey, Calif., for research and development work on *Minuteman* missile guidance and control equipment.

$4,500,000—**Lockheed Aircraft Corp**, Sunnyvale, Calif., for *Agena* space-exploration vehicles.

$4,000,000—**Lockheed Aircraft Corp**, Burbank, Calif., for support items for *Agena* space vehicles (supplemental contract). Work to be done at Sunnyvale.

$3,860,058—**General Electric Co.**, Syracuse, N.Y., for guidance and testing equipment for space exploration programs.

$2,902,847—**Raytheon Co.**, Lexington, Mass., for flight test and evaluation services of the *Sparrow III* missile system. Work to be done at Bedford, Mass.

$2,859,400—**North American Aviation, Inc.**, Downey, Calif., for *Minuteman* guidance and control systems.

$2,726,469—**Aerojet-General Corp.**, for *Titan* missile research at Sacramento, Calif.

$2,683,541—**General Dynamics Corp.**, San Diego, for work on *Atlas* missiles (2 contracts).

$1,788,050—**Raytheon Co.**, Lexington, Mass., for integration, installation, operation and maintenance of radar equipment at White Sands Missile Range, N.M.

$1,532,000—**Avco Corp.**, for work on a classified project. Work to be done at Wilmington, Mass.

$1,277,990—**Martin Marietta Corp.**, for *Titan* missile parts. Work to be done at Denver.

$1,256,520—**Lockheed Aircraft Corp.**, Burbank, for provision of *Agena* equipment and launch support (supplemental contract). Work to be done at Sunnyvale.

$1,154,187—**Western Electric Co.**, New York City, for designing and building a *Titan* missile inertial guidance system.

$1,000,000—**Lockheed Aircraft Corp.**, for making satellite vehicles at Sunnyvale, Calif.

$1,000,000—**General Motors Corp.**, for *Titan II* installations and tests at Vandenberg AFB, Calif.

$1,000,000—**North American Aviation, Inc.**, Downey, Calif., for guidance and control systems for *Minuteman* missiles.

$967,773—**Missile Systems Corp. of Texas, Emtex Div.**, Carrollton, Tex., for *Talos* guided missile MK 11 MOD 5 missile wings.

$118,925—**Thiokol Chemical Co., Reaction Motors Div.**, Denville, N.J., for production of *Bullpup* pre-packaged liquid rocket motors. Work to be done at Bristol, Pa.

$98,000—**General Dynamics Corp., Convair Div.**, New York, for fabrication and testing of a titanium component suitable for use in supersonic aircraft, missiles or space vehicles.

$71,670—**Foote Mineral Co.**, Exton, Pa., for investigating the uses of lithium chemicals in environmental control.

ARMY

$1,304,251—**Northrop Corp.**, for target missiles. Work to be done at Van Nuys, Calif.

$1,256,000—**Western Electric Co.**, for parts and maintenance for *Nike-Hercules* surface-to-air missiles.

NAVY

$2,116,408—**Hercules Powder Co., Inc.**, Rocket Center, West Va., for performance of contracts in the area of cast, doublebase missile propellants in support of the *Polaris* and fleet ballistic missile programs.

$1,631,521—**Lockheed Aircraft Corp.**, Sunnyvale, Calif., for test vehicles for the *Polaris* program.

DOD

$750,000—**Washington Technological Associates, Inc.**, for engineering design, development and fabrication of electronic and mechanical equipment for inclusion in space and missile programs.

NASA

$10,000,000—**Bendix Corp., Radio Div.**, Towson, Md., for operation of five of NASA's world-wide Project *Mercury* tracking and communication stations and certain engineering and operations services for all 16 *Mercury* network stations.

$2,400,000—**Air Force Systems Command**, Washington, D.C., for *Atlas* boosters and launch services in support of Project *Fire*.

$961,000—**Republic Aviation Corp.**, Farmingdale, N.Y., for fabrication of various items of space vehicle components for *Saturn*.

$300,000—**Space General Corp.**, El Monte, Calif., for development of an inflatable paraglider which will measure micrometeoroid flux in the lower region of space up to 700,000 ft.

$289,000—**Jered Industries**, Birmingham, Mich., for service and materials for designing, fabricating, installing and making necessary building modifications and test-operating a space-vehicle rendezvous docking simulator facility.

$250,000—**Ling-Temco-Vought**, Dallas, for *Apollo* rendezvous simulator study.

$211,000—**General Electric Co.**, Philadelphia, for designing criteria of zero leakage connectors for launch vehicles.

$175,000—**Hickham AFB**, Hawaii, for contingency recovery services in support of Project *Mercury*.

$100,000—**General Electric Co.**, Syracuse, N.Y., for overall integration, checkout and reliability of *Apollo* space vehicle system.

$100,000—**Spectrolab, Inc.**, North Hollywood, Calif., for design, development and fabrication of solar paddles for *S-3A* satellite.

INDUSTRY

$2,500,000—**Bell Aerosystems Co.**, Buffalo, N.Y., from Lockheed Missiles and Space Co., for 72 digital velocity meters for the *Agena* space vehicle.

$200,000—**Ilikon Corp.**, Natick, Mass., from **MIT Instrumentation Laboratory**, for development, selection and testing of certain metals to be used in the *Apollo* project.

$50,000—**Sperry Utah Engineering Co.**, Salt Lake City, Utah, from **North American Aviation Co.'s Space and Information Systems Div.**, Downey, Calif., for engineering assistance on a study of the in-flight test systems for the *Apollo* spacecraft.

United Aircraft Corp., Norden Div., Norwalk, Conn., from **General Electric Co.**, for 30 shaft position encoders for use in the *Polaris* program (undisclosed amount).

Circle No. 2 on Subscriber Service Card

soviet affairs

by Dr. Albert Parry

Communication satellites

of the near future, with an emphasis on globe-wide TV broadcasting, are discussed at length in the article "Television in the Sputnik Era" by Fyodor I. Chestnov in the Soviet monthly magazine *Moskva.* Known as the author of *Zagadka Ionosfery* (The Enigma of the Ionosphere) and other works of popular science, Chestnov in his article examines several proposed orbiting Earth satellites for TV broadcasting purposes, and concludes that the best system would be 35,800 kilometers distant from the Earth. He explains: "At this altitude a satellite would have the same angular speed of orbiting around our planet as the Earth itself has while orbiting around its axis. Should the satellite be launched from the Equator, and in the West-to-East direction, the observer on Earth would see such a satellite as motionless." At this altitude and angle the satellite would not be hampered in its TV broadcasting by any barriers "created for television by the globe-like form of ultra-short waves."

No reference to American experiments

and achievements is made by the Soviet author. The United States is mentioned only when Chestnov suggests that three satellites instead of a single one should be orbited at the same height, "to divide this orbit into three equal parts" so that the TV program of one of the trio can be simultaneously relayed by the two others—to cover the entire Earth. One of the three points to originate such a program could be Moscow, says the Russian, and New York and Havana could be the other two.

Soviet priority in TV satellite development

is claimed by Chestnov: "Already in 1958," he writes, "soon after the successful launching of our first *Sputniks,* the Soviet scientist S. I. Katayev read a report before the Popov Scientific-Technical Society of Radio-technology and Electrocommunication about the creation of a satellite with a television-broadcasting station. This bold idea met with complete approval." Chestnov goes on to speak of the use of TV in watching the behavior of the cosmonaut-dogs in the various *Sputniks;* of the work of TV in the *Lunik* launchings in 1959; and finally, of the TV performance in the Gagarin and Titov flights in 1961. All these accomplishments, Chestnov declares, augur well for the success of global TV programs once the Soviets orbit such communication satellites.

The year 1964 is mentioned

by Chestnov as a possible target date for the establishment of world-wide TV broadcasting from satellites. He points out that the next Olympics, to be held in Tokyo in 1964, should certainly be televised and broadcast globally via outer space. For this coverage, he proposes two projects, one involving three satellites, the other a dozen. He adds that color television could in time be a feature of such outer-space broadcasting (although he admits that in the USSR, so far, color television is used only experimentally). He also foresees tri-dimensional programs in the cosmic television of the future.

A "schedule" of flights to Venus

has been worked out and made public by a group of Soviet scientists (Y. P. Asksenov, Y. A. Grebenikov, V. G. Demin, and Y. N. Pirogov), according to an item in the Moscow monthly *Nauka i Zhizn'* (Science and Life). In their report these scientists also revealed the methodology of blueprinting such cosmic flights, not to Venus alone, but to other nearby planets as well, stating their ways of figuring the best trajectories and the best departure times for the spaceships. In this work they are said to have used a Soviet computer making 20,000 operations a second.



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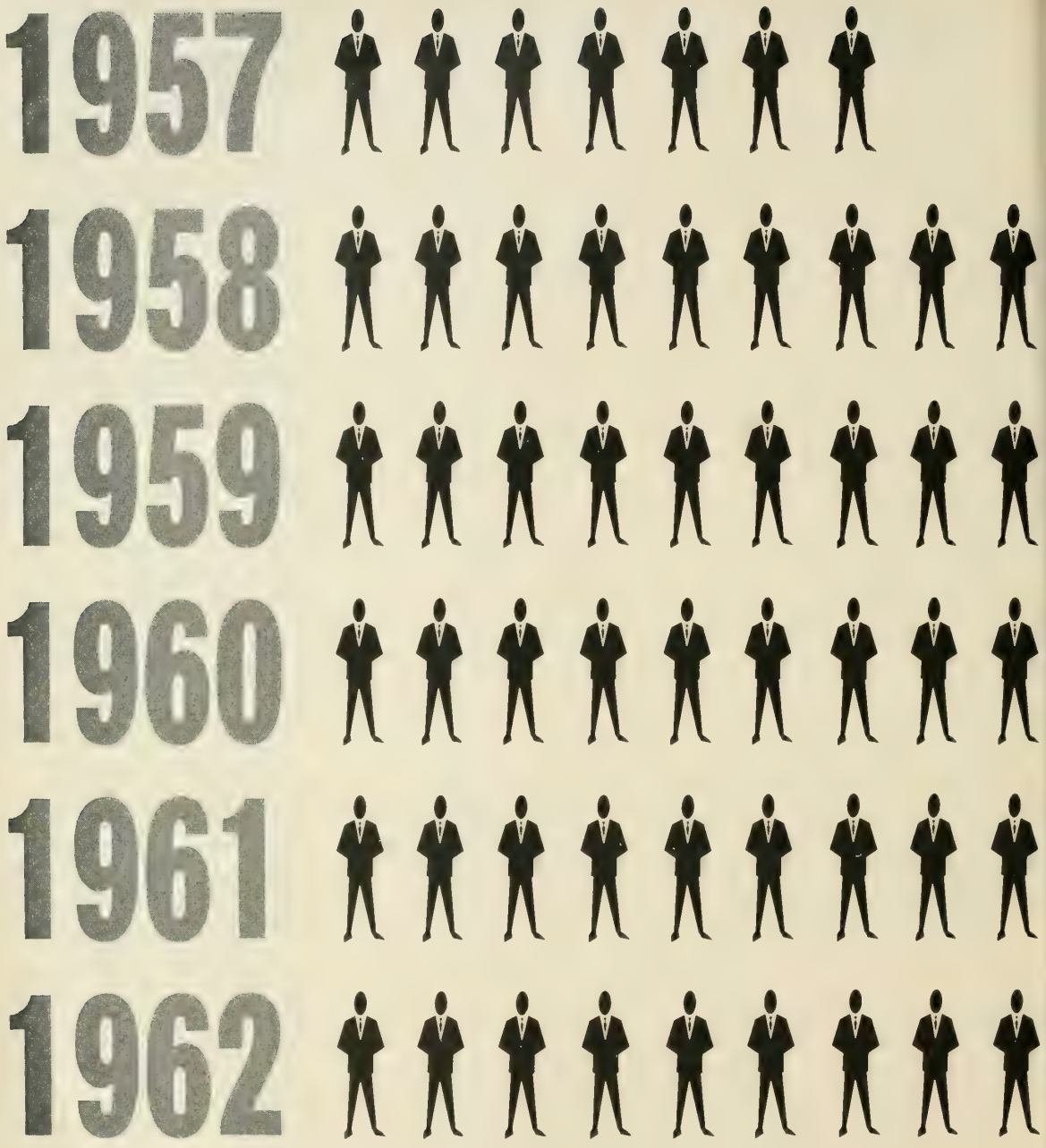
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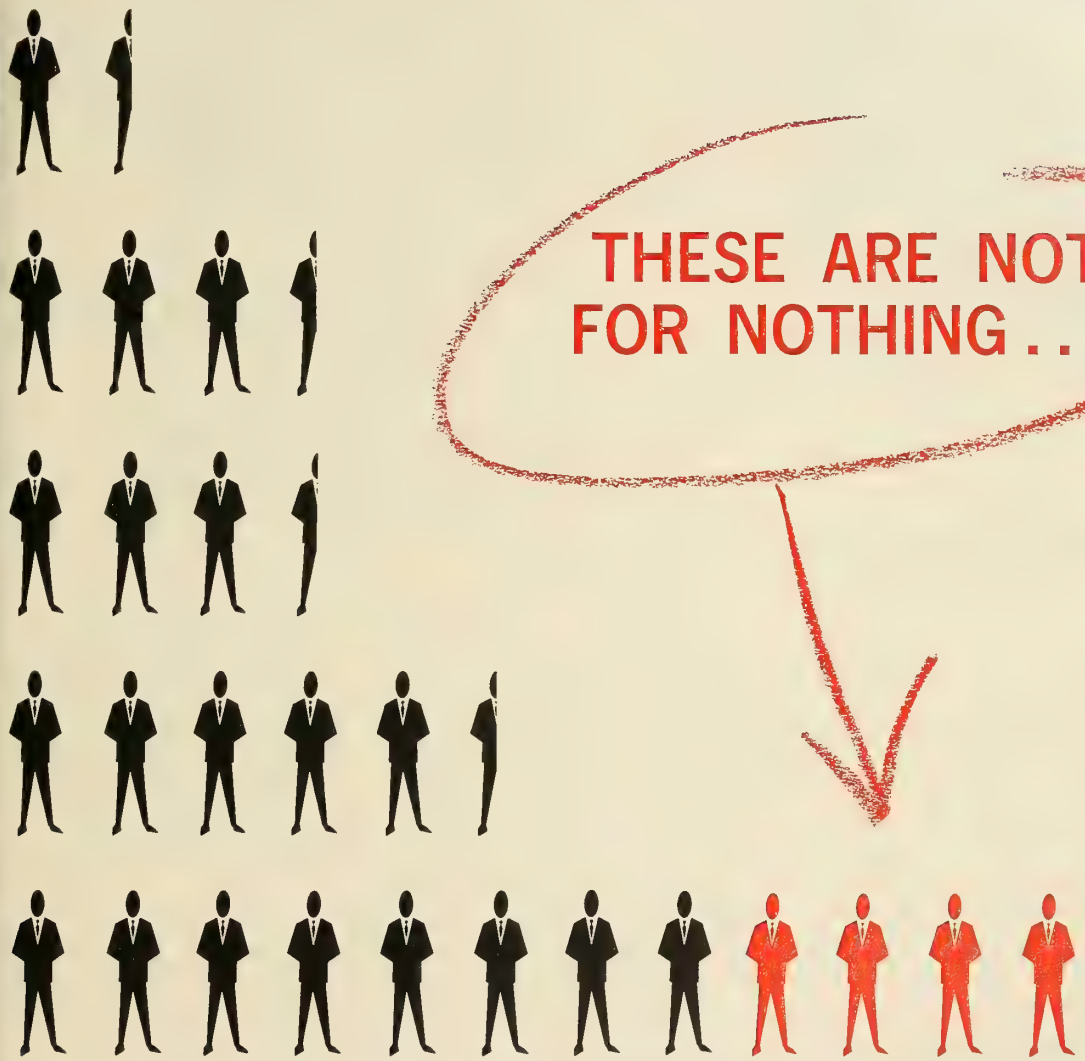
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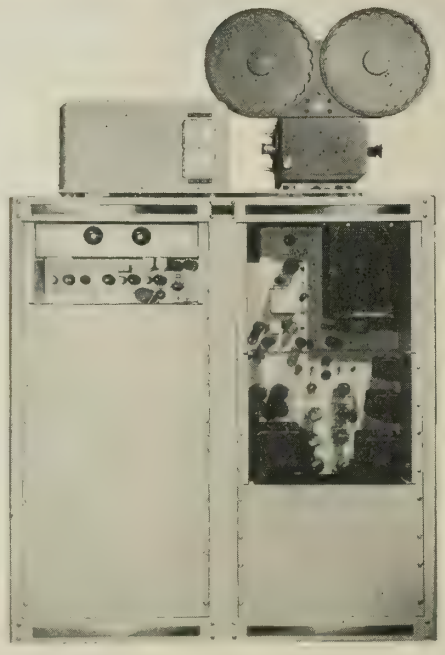
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products and processes



New Product of the Week:
Versatile Video Film Recorder

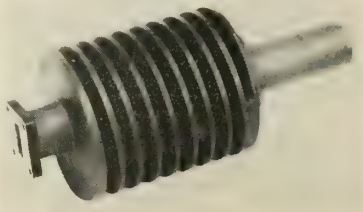
The RK 110, a video film recorder designed to operate with any broadcast or closed-circuit television system, is available from Vue-Tronics, Inc. Requiring only two controls, the unit can be operated by one person with a minimum of training. Proprietary design features have provided maximum kinescope protection; shutter adjustment, electronic shutters, camera phase generators, etc., have been done away with, since common shutter-bar and picture-splice distortion have been completely eliminated.

The RK 110 features horizontal resolution to 600 lines and vertical to 450 lines on a 525 line, or 600 lines on a 735 system. Linearity is within 1% of picture size, with differential gain distortion less than 5%.

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Waveguide Termination

A high-power wave guide termination is now available from Hewlett-Packard. The Model X913A dissipates 500 watts average power without forced air or liquid cooling. If desired, the termination can be force-cooled for greater dissipation. The termination is not damaged by severe overload, and can handle 100 kilowatts peak power using only convection cooling.



Circle No. 226 on Subscriber Service Card

Satellite Tape-Time Reference Clocks

Two tape-time reference clocks have been developed by Adcole Corp. for use in satellites employing a tape recorder to provide timing signals for correlation of satellite position with recording of data.

Adcole Models 211 and 214 Clocks feature outputs of one pulse per second at greater than 1 volt, and four voltage staircases of 8 steps each. The staircase outputs have widths of 32,256, and 16,384 seconds per step. The eight staircase voltage outputs are within the range of 0 to 5 volts.

Circle No. 6 on Subscriber Service Card

Model 211 uses an external 400 cps sine or square wave at 10 to 125 V rms as a basic frequency source. Model 214 uses an internal oscillator and is accurate to 2 parts in 10^4 over a temperature range of 65 to 140°F.

Circle No. 227 on Subscriber Service Card

High-Temperature Adhesive

Glom O-N, a low-temperature-curing, high-temperature adhesive in the 600°F class, is available from Thermo-Resist, Inc., for bonding dissimilar materials. The adhesive cures at 120°F, has a tensile lap-shear strength of 900 psi at 600°F, and ability to withstand cold to below −65°F.

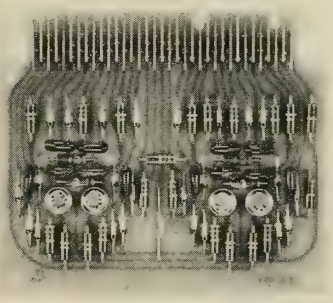
A unique feature of the two-components adhesive is a color change from chocolate brown to olive green to indicate that proper mixing of the components has been achieved.

Circle No. 228 on Subscriber Service Card

Plug-In Digital Cards

Computer Logic Corp. is marketing a CS-Series of digital circuit cards. Designed for counting and shifting operations, the plug-in cards are manufactured in three frequency ranges.

Model CS-1, containing two flip-flops, operates from dc to 300 kilocycles. The CS-2, also a dual function



card with two flip-flop circuits, operates to 3 megacycles. Modes CS-12 operates to 10 megacycles, to complete the series. Each card has two independent flip-flops with gates for counting either up or down; and shifting, either right or left.

Determination of any two of the four possible operations is made by socket wiring. Selection between the two chosen functions is made by a logical control line.

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Differential Transformer

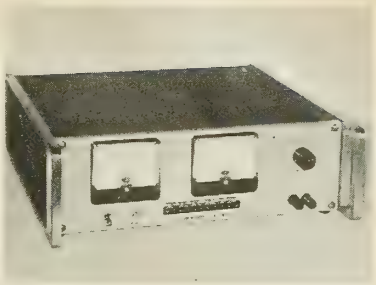
A series of transducer converters permitting the use the use of differential transformer-type transducers with 28 vdc and 115 vac power sources has been developed by the Transducer Division of Sanborn Co. These converters produce d-c signals proportional to the input, ready for monitoring or recording with a general-purpose d-c amplifier. No carrier amplification is needed. All converter circuitry is contained in a 9¾-in. x 1$^{15}/_{16}$-in. x 2-in. aluminum housing which has input, output and transducer connectors.

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Magnetic Amplifier

A magnetic amplifier-regulated 28 volts at 10 amps d-c power supply—designated Perkin Model number 28-10WXA—has been developed by Perkin Electronics Corp.

This power supply provides 24 to



32 volts at 10 amperes with automatic voltage regulation of −0.5% and ripple of 1% RMS.

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Candidates for these positions should have acquired broad design and analysis experience in solid rocketry with particular specialization in one or more of the following:

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- Grain design and interior ballistics
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- Nozzle design, gas dynamics and heat transfer
- Quality assurance, process inspection and non-destructive testing
- Handling and ground support equipment
- Combustion instability and detonation behavior
- Vehicle system integration

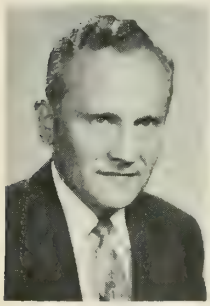
Openings exist for engineers, preferably with advanced degrees, whose minimum of ten years of professional engineering experience includes at least five years of successful employment in the solid rocket industry.

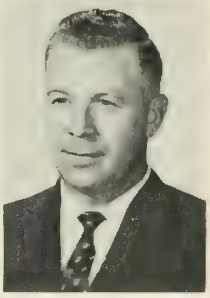
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names in the news


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Archie B. Japs: Manager of the B. F. Goodrich Aerospace and Defense Products rocket motor plant at Rialto, Calif., elected mayor of Rialto.

C. E. Lee Dunn, Jr.: Appointed manager of a new regional office of Thiokol Chemical Corp. in Houston.

Dr. Richard W. Ziemer: Joined Electro Optical Systems, Inc., Pasadena, as a senior scientist in the company's fluid physics division. **Robert Munk** named chief scientist. **Howard K. Manning** and **Warren M. Haussler** named senior staff members.

Donald K. Adams: Named manager of government relations department at Adler Electronics, Inc.

David J. Abromowitz: Appointed director of contract administration for the ordnance operation of Avco Corp.'s electronics and ordnance division.

Dr. Felix Zandman: Elected president of Vishay Instruments, Inc., Malvern, Pa.

Gen. Lucius D. Clay, USA (ret.): Elected to board of trustees of Aerospace Corp.

H. C. McDaniel: Director of technical information for Westinghouse Electric Corp., Philadelphia, elected president of the Society of Technical Writers and Publishers.

Sidney Herman: Appointed vice president of engineering of North Atlantic Industries, Inc., Plainview, N.J.

John G. Brooks: Named chairman of the board and chief executive officer of Lear-Siegler, Inc., Los Angeles.

C. Stanton Babcock: Appointed assistant to the president of the Stanford Research Institute.

Frank W. Vargo: Appointed quality control manager of Lear-Romec div., Lear, Inc., Elyria, Ohio.

John C. Owen: Promoted to executive head of PneumoDynamics Corp.'s Washington, D.C. office.

Louis Mager: Appointed executive vice president of U.S. Dielectric, Inc., Worcester, Mass.

Harold S. Pike, Jr.: Appointed assistant to the president of Nytronics, Inc., Berkeley Heights, N.J.

William H. Evans: Named director of NASA's Pacific Launch Operations Office at Point Arguello, Calif.

C. J. Moll: Appointed manager of the environmental contract department for the construction group of the Westinghouse Electric Corp.

George R. Gehrkens: Named executive vice president of North American Aviation's Columbus division.

Robert W. Bemer: Named director of systems programing for the UNIVAC division of Sperry Rand Corp.

James B. Huffman: Named manager of quality control for Electronic Communications, Inc.

Richard E. Bennett: Appointed general manager of Daystrom, Inc.'s transicoil division.

Gary D. Hainey: Promoted to quality control manager of Duncan Electronics, Inc.

Dr. Aaron Rose: Appointed thermodynamic machinery section manager of Marquardt Corp.'s aerospace propulsion program.

Fred D. Herbert, Jr.: Elected to the executive committee of the board of directors of General Precision Equipment Corp.

E. M. Shank: Appointed technical advisor to European Society for Chemical Treatment of Irradiated Fuels (Eurochemic) at Mol, Belgium.

Joe L. Browning: Named technical director at the U.S. Naval Propellant Plant, Indian Head, Md.

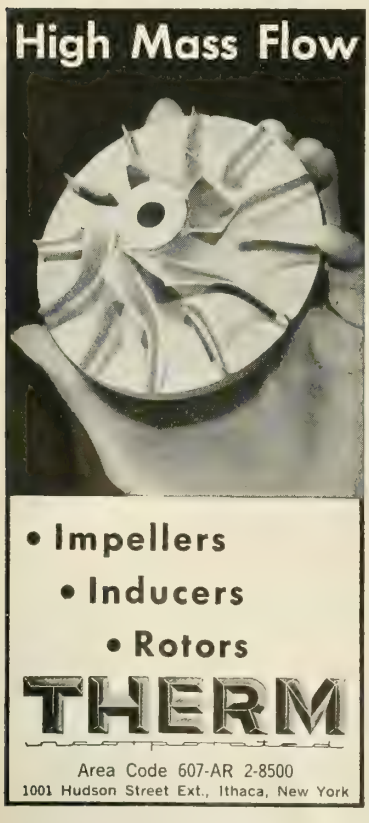
Raymond J. Staten: Named director of research and development at Integrated Electronics Corp.

Dr. E. T. Ferraro: Vice president, logistics, General Precision Aerospace, presented with the Greer Award.

Donald K. Adams: Joined Adler Electronics, Inc. as manager of the government relations department, military products division.

Richard L. Rigatti: Appointed general manager of Semi-Elements, Inc.

William G. Vorhaus, Jr.: Appointed contract administration manager for Wyle Laboratories.



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—when and where—

JUNE

American Nuclear Society, Annual Meeting, Statler Hilton Hotel, Boston, June 18-20.

Advanced Subject Matter Institute on Nuclear Rocket Propulsion, sponsored by the National Science Foundation, University of Florida, Gainesville, June 18-Aug. 10.

Technical Writing Conference, University of Michigan, Ann Arbor, June 18-22.

Institute of the Aerospace Sciences Annual Meeting, Ambassador Hotel, Los Angeles, June 19-22.

American Society for Testing and Materials Annual Meeting, Statler Hilton Hotel, New York City, June 24-29.

Symposium on Electromagnetic Theory & Antennas, sponsored by the Technical University of Denmark, Copenhagen, June 25-30.

Progress Report to the Military Electronics Industry Professional Group on Military Electronics, IRE, Shoreham Hotel, Washington, D.C., June 25-27.

Summer Institute in Dynamical Astronomy, Yale University, New Haven, Conn., June 25-Aug. 2.

ASME Aviation and Space Division Annual Conference, University of Maryland, College Park, June 26-28.

Third International Symposium on Rarified Gas Dynamics, sponsored by AFOSR, Directorate of Engineering Sciences, ONR, NASA, University of Paris, France, June 26-29.

Ninth Annual Symposium on Computers and Data Processing by the University of Denver's Denver Research Institute, Elkhorn Lodge, Estes Park, Colo., June 27-28.

Fourth National Symposium on Radio Frequency Interference, IRE, Town House, San Francisco, June 28-29.

JULY

Reliability Training Conference, sponsored by American Society for Quality Control, Princeton Inn, Milwaukee, July 8-15.

Twelfth General Assembly, NATO Advisory Group for Aeronautical Research and Development, Paris, France, July 12-13.

Technical Report Writing for Engineers and Scientists, UCLA, Los Angeles, July 16-20.

American Rocket Society, Lunar Missions Meeting, Pick-Carter and Statler Hilton Hotels, Cleveland, July 17-19.

AUGUST

1962 Standards Laboratory Conference, National Bureau of Standards' Boulder Laboratories, Boulder, Colo., Aug. 8-10.

Institute of the Aerospace Sciences, Man-Machine Competition, Olympic Hotel, Seattle, Aug. 10-11.

Pacific Energy Conversion Conference, Fairmont Hotel, San Francisco, Aug. 13-16.

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Speak Up, Mr. Secretary

WE THINK an explanation of what is going on inside the Pentagon in regard to the military space program should be given by Secretary of Defense Robert McNamara just as soon as possible. From all outward indications, the situation is a shambles.

Let's take a look at what is known.

Early this year, the Air Force began a strengthened and renewed drive for an expanded military space role based on a document called the Air Force Space Plan—distributed with an endorsing letter from Chief of Staff Gen. Curtis LeMay.

This met immediate opposition in the Department of Defense.

"We cannot visualize or define now a military mission for a man-in-space," Assistant Secretary John Rubel told MISSILES AND ROCKETS.

This has not been a unanimous DOD view. In fact, quite a schism has developed in this regard. The Air Force demand for a bigger role in space, including man-in-space, had met opposition from politicians of both the Eisenhower and Kennedy Administrations who insisted on emphasizing what they like to call the "peaceful use of space."

But in recent weeks, a change has been evident within the Office of the Secretary of Defense.

Deputy Secretary Roswell Gilpatric, speaking from personal notes with no advance text, in a May 2 speech admitted that the military space posture had been neglected and added: "Within the next six months, we will get about our business in this area." (M/R, May 14, p. 38).

On May 16, Gilpatric followed this with a public statement that "the Defense Department has decided to develop the technology of manned orbital systems able to rendezvous with satellites and then land at preset locations on Earth." These systems would be capable of "neutralizing" hostile satellites, he said.

Late in May, the Space Systems Division of the Air Force opened negotiations with a number of industry firms on three-month study contracts for the manned satellite inspector system, known officially as 621B and unofficially as *Saint II* (M/R, March 26, p. 43).

The group included such firms as Lockheed, Boeing, McDonnell, North American, Hughes and Raytheon.

Last Monday, June 11, due note of all this activity was taken in the lead story of the New York *Times*, which reported that the Defense Department was embarking upon a man-in-space program.

The day it appeared, the report was vehemently denied by Arthur Sylvester, Assistant Secretary of Defense, who stopped just short of calling *Times* correspondent John Finney a liar for writing it.

The firms which were to receive the study contracts on the manned satellite inspector system have been notified abruptly that all plans for these have been cancelled—on orders from the highest levels.

IT SEEMS a fair question to ask: WHAT IS GOING ON?

From surface indications, a fight appears to be brewing within the Administration which is strongly reminiscent of the struggle which led to Trevor Gardner's resignation over the ICBM program—or more properly, over the lack of an ICBM program.

There are people on the White House staff and in DOD who are either such idealistic dreamers or such ignorant clods that they will not awaken to the need for a manned defensive space system until hostile Soviet satellites are overhead.

To these babes in the woods, any talk of military space programs would prejudice negotiations with the Russians at the disarmament table. Shades of Munich! Can anyone honestly believe that the best position from which to talk disarmament with the Russians is a position of weakness? Obviously, someone can.

The manned satellite system proposed is one which would make it possible to rendezvous with and to destroy hostile satellites. It is a follow-on to the well-advanced 621A program. First step in 621A is the scheduled launch from Cape Canaveral of a *Satellite Inspector* satellite aboard an *Atlas D-Agena B*. Target satellites are to be launched by *Blue Scout*. Purpose is to demonstrate feasibility of satellite inspection by means of television relay.

But of what purpose is it to inspect a hostile satellite if it cannot be destroyed? The follow-on *Satellite Interceptor* program is intended to provide that capability.

This is a must. But the churlish actions which have resulted in cancellation of plans for the study contracts are endangering the nation's security.

We think Secretary McNamara should make a prompt effort to clear up the situation, which has been hopelessly confused by Mr. Sylvester's contradictory position and by the contract cancellations.

Unless, of course, the White House staff is running the Pentagon these days? This possibility suggests an even greater danger than that spectre of a Pentagon run by its own civilians, which is haunting a number of military men these days.

William J. Coughlin



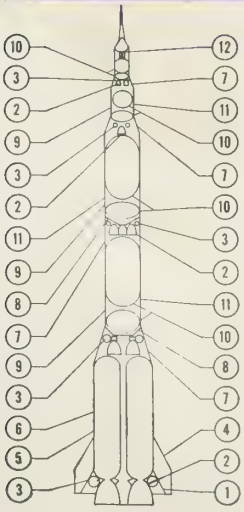
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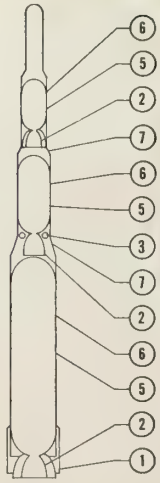
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missiles and rockets

E WEEKLY OF SPACE SYSTEMS ENGINEERING



Military Space Fight Continues Unabated

- DOD Told How It Can Cut Costs
- $50-60 Billion For NASA by '72?
- New Army Drone Formation Control

Pershing Reaches Activation

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...to survive in space: the moon and a Librascope computer

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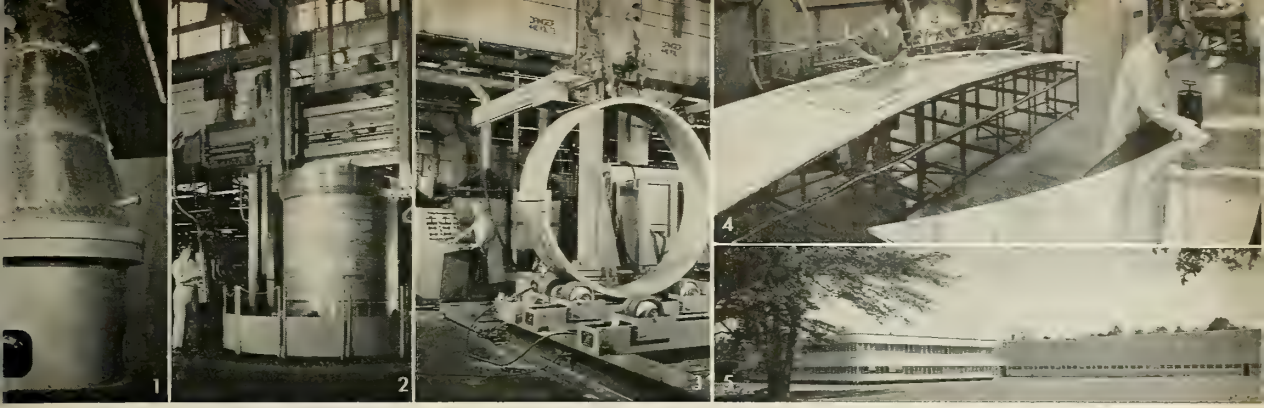


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EXISTING FACILITIES for initial requirements: (1) Tapco hydroclave forms large rocket nozzles; (2) Machines like this Betts have capacity to machine the 120"; (3) Welding of 120" metal structure done on these units that handle nuclear reactor cores; (4) The same honeycomb techniques developed for Sunflower will be used on big nozzle programs; (5) Adjacent to production, Tapco's Colwell Materials Research and Engineering Center acts as materials evaluator, process and quality control.

TAPCO "scales up" for big-booster nozzles

Now manufacturing the largest nozzle ever built for solid rocket boosters

Tapco is installing facilities to fabricate nozzles for various programs for big solid boosters in sizes ranging from 120″ to 260″. Various nozzles specifically for the 120″ engine programs will be completed this year with in-house facilities.

Thus, a long-time propulsion-component subcontractor moves with the rocket industry into its new era of colossal dimensions.

One of the most diversified supplier backgrounds in industry qualifies Tapco to make the transition . . . to enter production of big nozzles confident of meeting every requirement of the primes. And that background is this:

Materials: Personnel of the Colwell Materials Research and Engineering Center provide the knowledge and control of materials assisting in the design and for quality assurance and reliability of the end product. This has been demonstrated on nozzle programs including Minuteman, Polaris, Scout, Pershing and the Large Solid-Booster program.

Plastics Processing: Understanding of all nozzle-fabrication methods. From nozzle and special-product programs, Tapco has acquired first-hand experience with hydroclave, autoclave, high-pressure die molding, and tape and filament winding.

Machining & Welding: Large-component experience from production of huge nuclear reactor cores whose dimensions and quality requirements parallel big nozzles.

Honeycomb: Development of honeycomb structures as demonstrated by the 32-foot solar collector for the Sunflower system.

Logistics: In-house design and fabrication of special handling equipment from broad GSE experience with ballistic missile transporter-erector-launchers.

Inherent in this diverse activity is the experience of *program control* . . . planning, scheduling, routing, inspecting, liaison . . . for the efficient and economical delivery of reliable components.

It is this background that enables Tapco to proceed with the production of a full-scale 120″ solid-propellant booster nozzle.

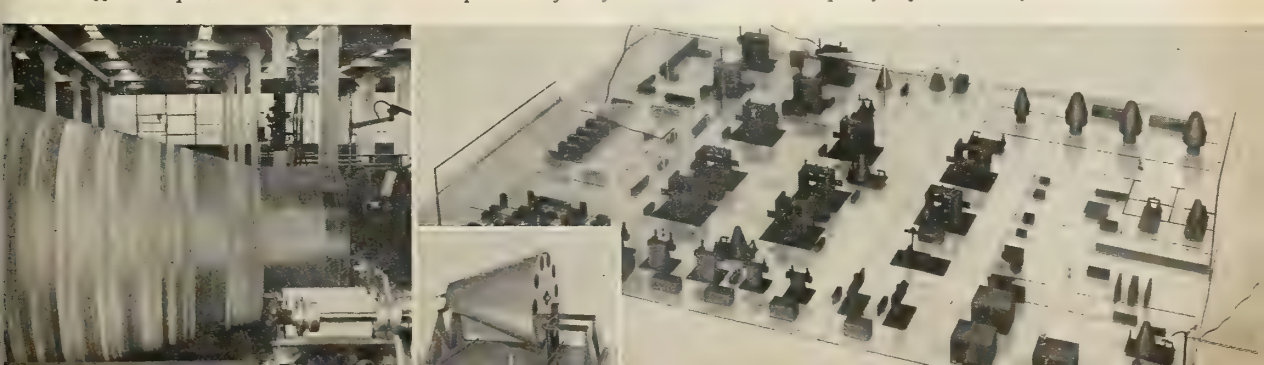
It is this experience that enables Tapco to plan in detail the "mass production" of 120″, 156″ and 260″ solid-propellant booster nozzles.

And it is this experience which permits Tapco to suggest that mass production can be reduced to a relatively simple "under one roof" undertaking *. . . at vast savings to the large booster programs.*

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FABRICATION of large solid-propellant rocket nozzles at Tapco.

"MASS PRODUCTION" is short step ahead: Three-dimensional detail of large-nozzle production facility. Inset shows vehicle developed by Tapco to route hydroclave mandrels.





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THE WEEKLY OF SPACE SYSTEMS ENGINEERING

missiles and rockets

Volume 10, Number 26 June 25, 1962

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THE COVER

Army's Martin Pershing long-range tactical missile is shown in elevated position near close of recent first public demonstration. The first Pershing battalion is being activated this week. See p. 23.



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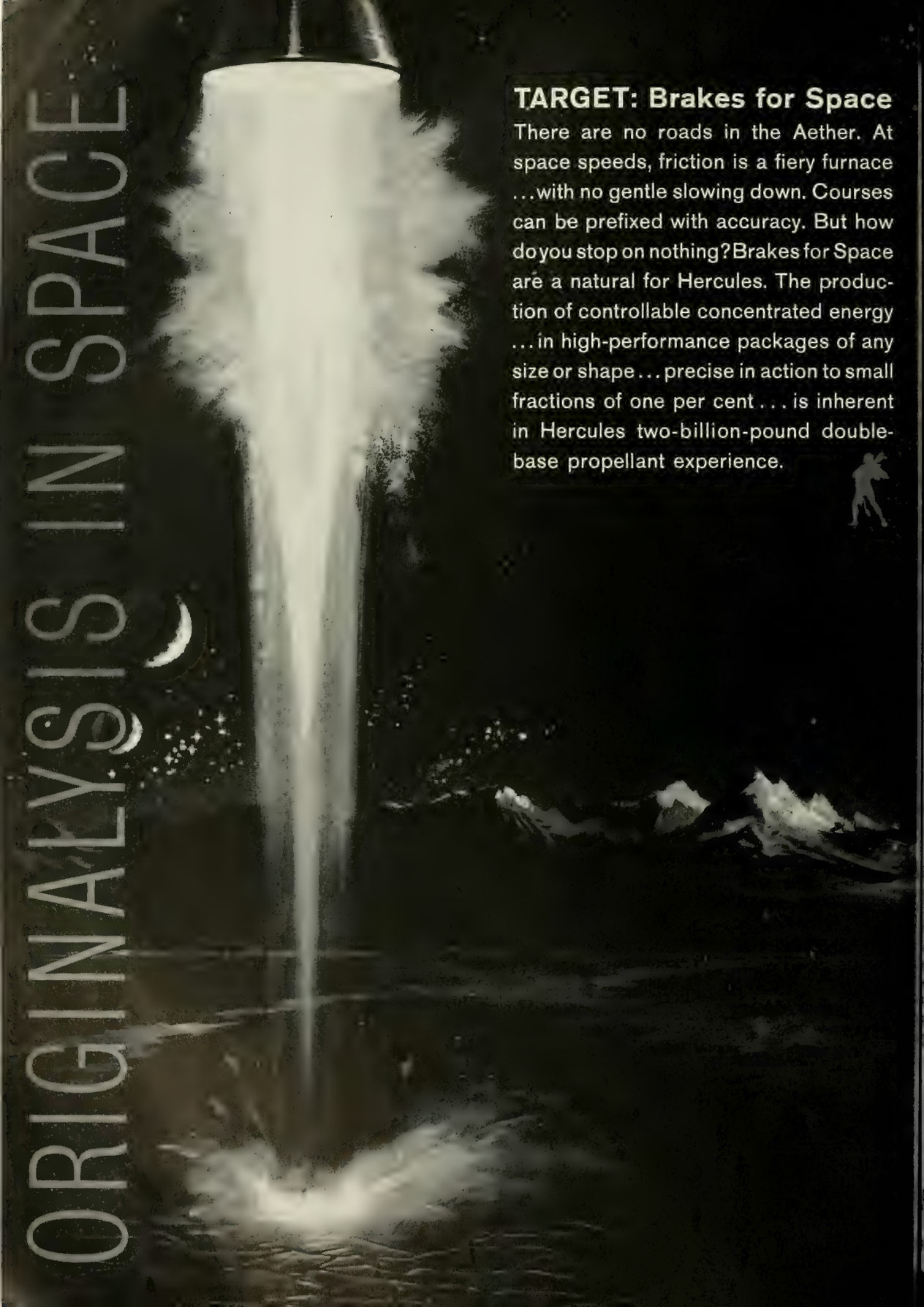
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letters

AFOSR Contracting

To the Editor:

I want to thank you in the most sincere terms for your June 11 editorial, "Innovation in Research Contracts." I can only hope that we have made a very substantial contribution to the improvement of contracting for basic research by the Department of Defense, and, additionally, I hope that your endorsement of our staff will prove to be justified by future events.

Knox Millsaps
Executive Director
Air Force Office
of Scientific Research
Washington

Hagan's Titan Work

To the Editor:

I was delighted with your feature story on our role in building the *Titan II* ground fueling and conditioning systems ("Titan II Fuel Tanks Open New Vistas," M/R, June 4, p. 31).

Small firms can successfully match their capabilities to our fast-developing space efforts, and I believe your story is an excellent example of defense subcontracting opportunities for smaller companies.

John G. Hagan
President
Hagan Industries
Corona, N. Y.

Sheffield's 'Modulab'

To the Editor:

We liked the article on AC Spark's Metrology Labs ("AC Spark's Metrology Investment," M/R, June 11, p. 24) so well . . .

We would appreciate permission to reprint for distribution to our sales force.

You see, we supplied the mechanical metrology lab shown at the top of page 25. This controlled-environment enclosure is known as the "Modulab," to be precise. Of course it is quite easy to see why the folks at AC dubbed it the "Silver Diner."

Charles G. Nobis
Advertising Dept.
The Sheffield Corp.
Dayton, Ohio

Permission granted.—Ed.

Anti-Lunar-Orbit

To the Editor:

The Houbolt plan described in "NASA Leaning to Lunar-Orbit Rendezvous" (M/R, June 11, p. 12) seems like a way to reduce cost at the expense of Astronaut safety. If timing, programing and velocity are not perfect, when the "bug lander" ascends from the Moon to intercept the lunar-orbiting return modules rendezvous will not be attained. The limited propellant supply will not permit another try; consequently, the two Astronauts would remain in lunar orbit listening to the condolences from *Apollo* control until they starved or suffocated. The safest way will be to land on the Moon with the entire vehicle necessary to return as originally planned.

It would be wise to develop two approaches to the lunar landing. One way should probably be the three-man, two-section Earth-orbit rendezvous using two *Saturn C-5* boosters, and the other a direct two-man approach using one *Saturn C-5*. In the latter, by making it an 85-hour trip instead of 60 hours, the Moon can be reached with sub-escape speeds. The *C-5* escape payload is 75,000 lbs., but a six-million-lb. *C-5* can produce eight million lbs. thrust and, using sub-escape speeds, have over a 90,000-lb. payload. The landing stage of this payload could have two outrigger propellant tanks with fuel enough to complete departure, maneuver into lunar orbit and execute descent retro firing. Then the outriggers would be jettisoned and the landing stage would brake, translate and soft-land a 30,000-lb. vehicle, 22,000 lbs. of which would be a return stage. After ascent back into lunar orbit, the 31,000-lb.-thrust double XLR-81 *Agena* motors would be jettisoned and the stage verniers would be used to return the modified *Gemini* capsule to Earth.

Whatever we choose, we'd better hurry because, contrary to the complacency of some Washington officials, the Soviets are still in this race. Our conclusion that they are having economic problems and cannot afford a Moon program is exactly what they want us to believe. We are being very naive to think they would not use every shortcut possible.

John B. Stevenson
Wickliffe, Ohio

Solar Flare Prediction

To the Editor:

I believe the short item on Solar Flare Prediction on pp. 36-39 of your June 4 issue may be misleading to some of your readers.

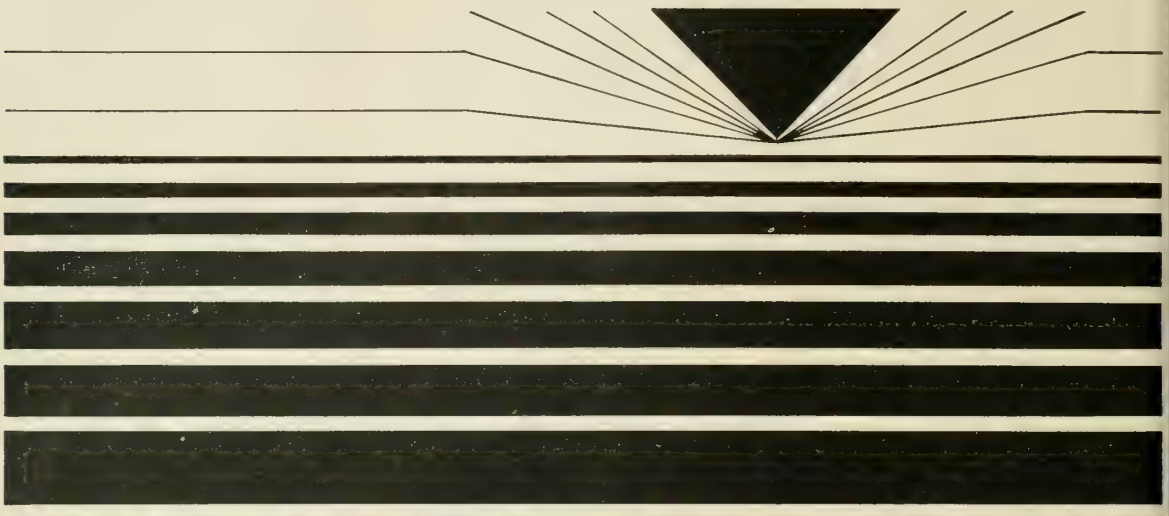
Flights made at the low altitudes currently used by both American and Russian astronauts are shielded from solar-flare radiation by the Earth's magnetic field. Consequently, there is no reason to assume that the Russians made use of flare-prediction techniques in scheduling their flights, or to be concerned about our not using them. However, future flights above the Van Allen belt, including lunar missions, will be exposed to such radiation. In these cases accurate solar-flare prediction could conceivably result in decreased shielding requirements and greater safety.

Herbert S. Appleman
Lebanon, Ill.

It's true there is no radiobiological hazard in the orbital trajectory of current U.S. and Soviet manned flights. Flare-induced disturbances could, however, upset communications. Hence a "safe" solar flare prediction is now a prerequisite for U.S. manned launchings.—Ed.

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ENGINEERS/SCIENTISTS JOIN US IN GIVING A NEW DIRECTION TO AEROSPACE TECHNOLOGY



the last 50 miles are the hardest

re-entry— Only One of the Critical Aerospace Problem Areas for which REPUBLIC'S PAUL MOORE RESEARCH CENTER has R & D Contracts

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- . . . Closed Ecological Systems
- . . . Guidance for Orbital Rendezvous
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- . . . Next Generation Orbiting Solar Observatory

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The Countdown

WASHINGTON

Further Centaur Slippage Seen

Members of the House Space Committee are fuming over possible further slippage in the *Centaur* program. They have learned that NASA is considering delay of the second shot in the upper-stage development program from October until January. During recent committee hearings on the program, NASA told the committee the October date was firm. Committee members feel NASA deliberately misled them. NASA blames the new delay on unavailability of certain vehicle components.

ALBM Design Selected for RS-70

An *ALBM* design for the supersonic RS-70 bomber, based on a design submitted by Hughes Aircraft, has been selected by the Air Force. Six different guidance systems for the air-to-surface missile have been studied, ranging from complete systems to breadboard models.

Agreement Reached on Tracking Ships

NASA and Department of Defense have agreed that eight to ten ocean tracking ships will be needed for their combined space programs. These will be required in the four-to-five year period just ahead. More probably will be added later.

New Weather Satellite Study Coming

Bids will be asked shortly on a NASA study contract to determine requirements of an operational meteorological satellite system. The study will be focused principally on design requirements of *Aeros*, NASA's most advanced weather satellite.

New Missile Sought for TFX

Navy officials are pressing hard for development of a new missile for the forthcoming TFX aircraft. But if approval is not received, they will fall back on Raytheon's *Sparrow III*.

Solids Ruled Out for Apollo

Defense Department officials now are saying large solids definitely will not be developed for the *Apollo* program. Research director Harold Brown says a 260-in. motor is too large for military requirements. He says no military need has yet been established for very large solids, although they may be sized for whatever mission finally is assigned to *Nova*—excluding direct flight to the moon.

MIDAS Program is Re-Oriented

A revised development plan for *MIDAS* is due for submission to Department of Defense this week. It reflects re-orientation of *MIDAS* from a system utilizing satellites in a controlled orbital net to a simplified system of satellites in random orbits. The study also includes plans for early flight-testing of improved payloads. Full funding of the program has been deferred until the plan is approved. Present AF planning calls for operation of the *MIDAS* and *SAMOS* spy satellites through the late 1960's, when a follow-on system is expected to be available.

Slippage Expected in Syncom Launch

Feuding over the now-defunct *Advent* program continues. Despite earlier DOD claims that *Advent* ground stations will be ready for *SYNCOM*, Congress has been told this schedule may not be met. NASA officials, meanwhile, are saying a September date could have been set for *Syncom* except for the ground station delay. The further slippage means the first flight, now set for January, may be delayed even further.

LOR Appears a Winner

Insiders say approval of Lunar Orbital Rendezvous for the *Apollo* program is all but final. Decision may not be announced by the July 1 target date, however. A delay is expected until after Congressional approval of the NASA budget.

INDUSTRY

AF Resumes Study Program

Air Force study program—suspended two years ago—is back in business with some $5 million in FY '63. The program has been urged on Defense officials on the basis that AF needs these long-range studies to adequately develop long-range plans and programs.

No Changes for Aeronutronic

Henry Ford II says recent management changes at Ford's Aeronutronic Division do not forecast any change in direction for the division, other than internal. He told COUNTDOWN there also are no plans for merging Aeronutronic and Philco activities in the immediate future. The *Shillelagh* program, incidentally, is said to be back on the track after earlier troubles.

Jam-Proof IR Communications Claimed

Raytheon's Missile and Space Division in California reports it is nearing completion of development of a jam-proof IR communications system between moving airborne platforms up to 100 miles apart. The two-way voice carrier is a narrow IR beam, 1/10 of a degree wide, which spreads to about a 50-ft. diameter at a 50-mile range. A 10-watt lamp about the size of a flashlight bulb reportedly will send the beam the full 100 miles.

INTERNATIONAL

New Marine Missile Platform Developed

A revolutionary British marine platform suitable for use in missile tracking and detection system has been developed by Intercontinental Marine Development Ltd. (33 Bruton St., London, W. 1) in association with Cammell Laird & Co. (Shipbuilders and Engineers) Ltd., Birkenhead. Known as the Triton platform, it is capable of carrying from 25 to 1000 tons payload. Exceptional stability is claimed even under hurricane conditions.

BASIC RESEARCH

POSITIONS FOR SENIOR SCIENTISTS & ENGINEERS IN

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Armour Research Foundation's engineers and scientists are currently investigating basic concepts regarding thermal properties of materials at high temperatures, transient heat conduction problems, reentry heat transfer studies, heat transfer problems of composite materials, fire research, fire storm analysis, and other challenging research.

The Fluid Dynamics and Propulsion Research Division of ARF has openings for M.S. or Ph.D.'s in Ch.E., M.E., or Fire Protection Engineering who have an interest and academic background in one or more of the following areas:

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This program is part of the Armour Research Foundation's broad research, development and experimental research activities, sponsored by industry or government, in 6 varied areas: fluid dynamics and propulsion, chemistry, physics, metals and ceramics, mechanics and electronics. Complete facilities are available in each of these areas for application to any of ARF's undertakings. Included are an IBM 7090 and a Univac 1105 with large memory libraries.

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The Missile/Space Week

Shots of the Week

Tiros V—NASA's 285-lb. weather satellite—was successfully launched from Cape Canaveral June 19 by a three-stage *Thor-Delta*.

In spite of a malfunction in the radio command guidance link which forced the *Delta* to rely completely on its autopilot to guide it into the correct orbit, the RCA-built satellite is functioning normally, NASA officials said.

The fifth in a series of developmental weather satellites, *Tiros V* was injected into an orbit which will allow it to provide valuable data on the growth of hurricanes as well as the break-up of ice in the northern latitudes. (M/R, June 18, p. 15). The satellite began relaying data to ground stations on its third orbit.

Instead of a hoped-for 400-mile circular orbit, the satellite is travelling in an elliptical path with an apogee of 604 miles, a perigee of 367 miles and a period of 100.5 minutes. The difference in orbit, however, is not expected to significantly affect the operation of *Tiros V*.

• The second of a series of high-altitude nuclear tests in the Pacific failed June 20 when the *Thor* booster carrying the one-megaton weapon malfunctioned and was destroyed less than 120 seconds after launch.

It was the second failure of a planned series of 3-4 high-altitude tests to determine the effects of nuclear weapons at these altitudes. The first test (M/R, June 4, p. 12) was to have been of intermediate range and exploded at an altitude of about 60 miles. The second shot (M/R, June 12, p. 18) was to have been exploded at about 500 miles altitude.

No information on the cause of the malfunction was released.

• A Martin *Pershing* missile apparently destroyed itself shortly after second-stage ignition June 14, following a launch from Cape Canaveral. More than 100 newsmen and project officials were on hand to watch the firing. It was the seventh failure for the Army's, 400-mile solid-fueled missile in 38 launches. (see p. 23.)

• The AF attempted to launch two "secret" satellites from Point Arguello, Calif., and Vandenberg AFB, Calif., June 17 and 18 using a *Thor-Agena* for the first and an *Atlas-Agena* for the second.

Due to the DOD policy of not releasing launch or orbital data, it was not known whether either satellite went into orbit.

• Two launchings of the Canadian *Black Brant* sounding rocket were conducted at NASA's Wallops Island, Va., station last week to check the performance of the new rocket. Both successfully carried payloads to about 58 and 62 miles, respectively, before falling back into the Atlantic Ocean.

• An *Asp* atmospheric sounding rocket was successfully launched from Canaveral June 14 as part of a program to gather meteorological data for the *Pershing* flight tests. The launch was the first in a planned series of five.

Space Directive To Be Declassified

Department of Defense Directive S-5200.13—the controversial order classifying military space projects—is expected to be declassified soon, a spokesman for the Special Government Information Subcommittee of the House Government Operations Committee told M/R last week.

The action is expected to result from staff discussions with representatives of DOD over the past two months as well as a letter from subcommittee chairman, John E. Moss (D-Calif.) to the Secretary of Defense.

Released last week, the letter—dated June 7—noted that Under Secretary of the Air Force Joseph V. Charyk has "indicated that the directive in question . . . could easily be declassified by means of a deletion, or a simple revision." Moss expressed the hope that "the steps necessary to provide a declassified version" would be taken.

However, Rep. Moss in his letter to Secretary McNamara said "it has become apparent that many persons outside the government—industry, the scientific community and communications media—are deeply concerned about the possible effect of the directive. In addition," he said, "members of several Committees of Congress which are vitally affected have expressed their interest."

Existence of the directive was disclosed April 12. Although it is classified—presumably to prevent disclosure of *Midas* and *Samos* space

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launchings—the order precludes the release of any information about military satellites except the location of the launch and the type of vehicle used (M/R, April 16, p. 13).

Advanced ComSat Work Begins

NASA has started developement of the second generation of its high- and low-altitude communications satellites.

Hughes Aircraft Co. was selected for negotiation of a $2.5-million contract to study problems involved in developing an advanced *Syncom* satellite to fly in a 22,300-mile equatorial orbit synchronous with Earth's rotation.

Meanwhile, NASA officials said plans for development of an advanced low-altitude *Relay* satellite will be announced in the near future.

They said a study contract probably will be awarded as a first step.

It was emphasized that no flight units would be developed under the Hughes contract.

Navy Gets Missile Ship

The Navy on June 16 commissioned its first submarine tender to be built since World War II—and the first completely designed to support the Lockheed *Polaris* system.

Named the Hunley, the tender is capable of repairing the fleet ballistic missile submarines and servicing and maintaining the nuclear powerplants of the *Polaris*.

UN Agrees on Space Program

The United Nations Space Conference wound up its technical and scientific subcommittee work last week with an agreement for a world-wide technical program for peaceful exploration of outer space.

With both the U.S. and the Soviet Union represented at the 28-nation meeting, the conference agreed on a world-wide exchange of scientific data, encouraged a series of international space research and training projects and recommended establishment of an international launch site for sounding rockets near the equator.

Grissom Gets White Award

Virgil Grissom, the second U.S. astronaut to make a suborbital space flight, was awarded the Thomas D. White Air Force Space Trophy last week for "meritorious achievement in contributing to the advancement of human knowledge of technology and a demonstration of man's capabilities in suborbital space flight."

Hydro-Space News



Yogi Bear© Hanna-Barbera Productions, Inc.

"Yogi Bear" Bailed Out

A short time ago, a 125-lb bear—destined for immortality in aviation annals—found himself hurtling through the stratosphere at 1060 mph after having been ejected inside a capsule from a B-58 bomber. Minutes later, he and the capsule had floated the nine miles to earth—pressurized, protected and intact—a convincing demonstration of the escape system's efficiency.

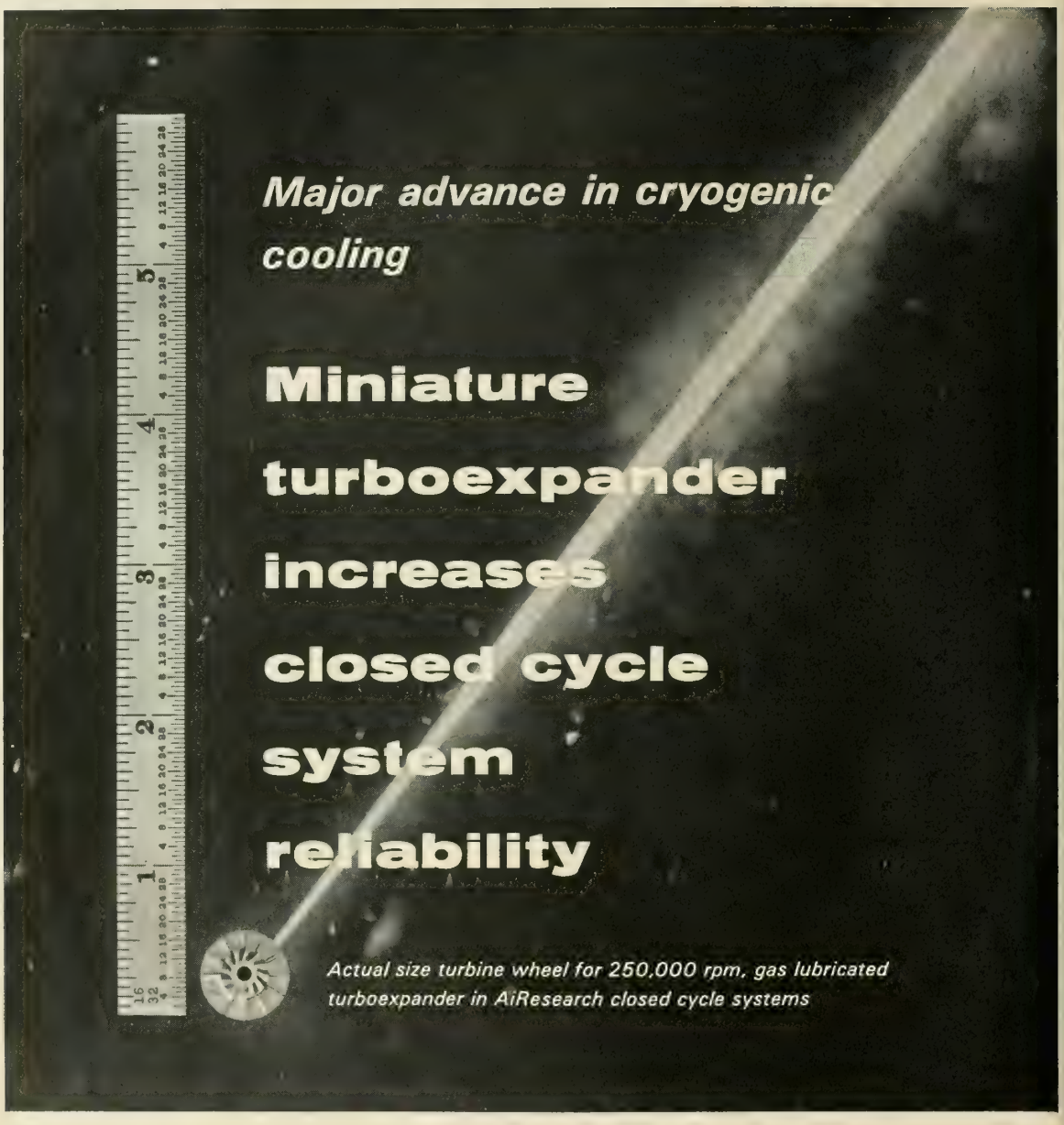
Although the shaggy "test pilot" will never know it, he owes much of the credit for his supersonic escape to emergency devices developed and manufactured at Hydro-Space Technology.

Hydro-Space Technology has designed and manufactured a wide variety of cartridge-actuated devices for use in aircraft, missiles and underwater research. They include ballistic gas generators, thrusters, valves, cable cutters and other cartridge-actuated devices. We'll be glad to describe them in full detail and answer any questions you may have. As a start, we suggest you write, on company letterhead, for a copy of our booklet, "Cartridge Actuated Devices & Oceanographic Equipment."

HST Hydro-Space Technology INCORPORATED

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Garrett-AiResearch is completing development work on closed cycle nitrogen, helium and neon systems using a tiny turboexpander in place of a piston expander.

This promises to dramatically increase system reliability and service life because all wearing surfaces, valves and troublesome reciprocating loads have been eliminated.

These compact, lightweight systems for masers, parametric amplifiers, IR cell cooling and computer components are ideally suited to commercial applications as well as military ground and aerospace uses.

AiResearch was first in production with an open cycle IR cooling system, and has already produced a closed cycle nitrogen system. The company is now working on military programs for 30°K and 4.2°K closed cycle systems.

Utilizing its experience as a world leader in lightweight turbomachinery and cryogenic cooling, AiResearch is also developing an all-turbomachinery closed cycle system incorporating a turbocompressor as well as turboexpander.

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Policy statement delayed . . .

Military Space Fight Rages

DOD denies AF space role exists, but holds out space-station possibility; AF, industry discuss secrecy

SCORCHING from a White House tongue-lashing, the Air Force was seeking other methods this week to push its plan for a manned military space program.

These developments came in quick succession last week as the military space battle continued to flare within the Administration:

- Top Department of Defense officials appeared before Congress to bat down reports of a go-ahead from DOD for an expansion of military man-in-space projects.
- The Air Force called an unannounced meeting in California with a number of defense contractors to seek a way around DOD restrictions on release of data about miiltary space efforts.
- Reports persisted that the order to withdraw contract plans for *Manned Satellite Interceptor* feasibility studies came from President Kennedy himself.
- Presidential intervention also was given as the reason for the angry attack by Assistant Secretary of Defense Arthur Sylvester on a *New York Times* story reporting a step-up in military manned space programs (M/R, June 18, p. 46).
- The battle delayed preparation of an Administration statement on National Space Policy, although this was classed as a minor document which would contain no major policy changes.

Dr. Harold Brown, director of Defense Research and Engineering, told the Senate Space Committee on June 14 that there is "no definable military need" at this time for manned space vehicles. He expressed doubt that manned space vehicles will ever have a military use.

But the DOD research chief added: "If five to eight years from now one develops or is forced upon us, we don't want to have to take five years to develop manned space systems."

He admitted it is difficult now to define accurately the specific characteristics that future military operational systems of many kinds will have.

For this reason, he said, DOD plans to engage in a broad program covering basic building blocks which will develop technological capabilities to meet many contingencies.

"In this way," he told the Committee, "we will provide necessary insurance against military surprise in space by advancing our knowledge on a systematic basis so as to permit the shortest possible time lag in undertaking full-scale development programs as specific needs are identified."

- **AF gain?**—However, relatively enthusiastic remarks by Dr. Brown indicated that the Air Force may have gained a significant victory in its drive for a manned military test space station.

He noted that DOD has conducted many studies on the concepts of space logistics, maintenance and repair to determine if the benefits are worth the price.

"Given the proper experimental environment which could be provided by a space station," Brown said, "it is possible that certain developments could be simplified, crew rescue techniques could be developed and practiced and experiments such as those on artificial gravity could be conducted."

"Perhaps such stations cannot be justified for any one of these purposes at this time," he added. "However, the variety of experiments which could be accomplished and the uncertainty of our military needs may make it desirable to have one. We are therefore continuing studies along this line."

Air Force officers have testified before Congressional committees that a manned military space station is urgently needed to test techniques, components and systems in the true environment of space.

- **One space program**—Newspaper reports that DOD was developing the technology for manned satellites went beyond what Secretary of Defense Robert McNamara and he believe to be the facts, Brown told Committee Chairman Robert S. Kerr (D-Okla.).

There have been no changes in the DOD program since the March appearances of Secretary McNamara before committees of Congress, Brown said. He also disclaimed any pressures for an expanded military space program by the National Aeronautics and Space Council.

The newspaper reports, based on speeches by Deputy Secretary of Defense Roswell Gilpatric on May 2 and May 16, appeared in a lead story in the *New York Times* and caused military space advocates to beat a hasty retreat in the face of angry, top-level Administration reaction (M/R, June 18, pp. 9, 11 and 16).

Brown's testimony buttressed that of Gilpatric, who appeared before the committee the previous day. Emphasizing that "some people have the erroneous impression that there are two space programs—a NASA program and a DOD program," Gilpatric pointed out that there is only a National Space Program—which he said will continue to be carried out by NASA and DOD working together.

Citing numerous examples of what he called the "intimate working relationships at all echelons" between DOD and NASA, Gilpatric made it clear that while DOD is playing a major role in NASA's *Gemini* program, the Department is interested in developing itself the technology of satellite rendezvous with particular emphasis on the ability to rendezvous with a non-cooperative target.

"We have as yet no approved program for development of a manned orbital system," he added, in what may have been carefully considered wording.

- **Statement deferred**—It was disclosed elsewhere that interagency disagreements have delayed preparation of a Kennedy Administration statement which will summarize National Space Policy.

The unclassified paper was slated for presentation to the White House by July 1. But it is now clear that it will

(Continued on page 14)

NSIA Study Hits 'Cost-Oriented' Buying

by James Trainor

THE U.S. IS PAYING more than it should for defense because of "cost-oriented" Pentagon procurement practices, a leading industrial association has informed Defense Secretary McNamara.

"Meaningful economic incentives which would cause cost reductions to come about naturally and in greater volume" are lacking in the present set-up, said a study by the Cost Reduction Task Force of the National Security Industrial Association. The study, undertaken a year ago at McNamara's request, was made public last week.

It points out that defense procurement is carried out in a cost- rather than price-oriented atmosphere.

"In such a . . . situation," the report says, "with profits or fee tied to costs rather than value received, the natural tendency is for costs to increase in spite of cost-reduction techniques, no matter how conscientiously they are applied."

The study recommends that DOD:

—Use more fixed-price contracts and use them earlier in the procurement cycle.

—Use incentive and penalty features when cost-reimbursement or cost-redeterminable contracts are appropriate.

—Emphasize price analysis rather than cost analysis in buying.

—Eliminate overlapping and multiple reviews of contractors' and subcontractors' purchasing systems, estimating systems, and small business programs, by limiting this function to an agency having cognizance of or at the contractor's or subcontractor's plant.

—Place technical and procurement groups under a common leadership and responsibility.

—Encourage alternative proposals which offer product-improvement and cost-reduction possibilities.

—Reduce Government control of the industry to permit the Defense program to benefit from cost controls and incentives provided by free enterprise.

On the last point, the report states, "undetermined but vast sums have been expended within government and industry for compliance with such supervision and control—for which corresponding values have not accrued to the overall defense effort. Hence, immediate cost reduction of significant proportions should follow the abolition or relaxation of such controls."

• **Study effort outlined**—The Cost-Reduction Study, says NSIA President E. V. Huggins, reflects the efforts of some 200 people, representing over 60 defense suppliers from "a cross-section of American industry." Ten task committees prepared reports on their specific area of concern. In all, Huggins said, over 680 man-meeting-days were devoted to study and report preparation.

• **Program packaging & DOD**—"In some areas," the study says, "further centralization into the Department of Defense of policy determinations, supervision or controls, is desirable if cost reductions are to be effected."

However, although the NSIA recommendations would lead to a greater centralization of procurement management, the association makes it clear that it is not recommending "so drastic a step as a single agency for procurement."

Strongly endorsing the "Program Package," the report asserts that "the concept must become one of the key government-industry tools in planning, initiating and funding adequately each successive annual increment of effort required to achieve program objectives in major weapon systems procurements."

The report recommends that programs be identified in the budget review process as:

—Accelerated: Increased costs incurred to save time.

—Optimum: Time-Cost relationship in balance.

—Stretched: Lower cost increments incurred at the expense of program completion time and cost.

Funds should not be reprogramed from basic or applied research accounts to "bail out" development programs, the study adds.

To improve cost-estimating procedures, the report recommends a "two-stage estimating procedure" in which the initial estimates would be prepared, as at present, "within the limits of available time to meet whatever work statements and specifications are available." Initial target costs and fees would be established only as a basis for preliminary negotiation of the contract and interim billing purposes.

At an agreed-upon time, a second look would be taken at the work statement, specifications and procurement requirements and complete new cost estimates would be prepared. ⌗

(Continued from page 13)

not meet the deadline. The delay could drag on for several months.

Administration officials report that the paper will call for no major changes in the current NASA and DOD space programs. Instead, one official said, it will attempt to bring together in one paper all of the various statements on the space program which have been made in speeches and in budget presentations to Congress.

Disagreement within the Administration centers on just how strongly the military role in space will be stressed. Air Force desires for increased military emphasis are opposed by top officials in DOD, the State Department and the White House itself.

The most the Air Force can now expect is that the paper will say that while the National Space Program is dedicated to the peaceful uses of space, one aspect is protecting the peace. It may state that, as a result, part of DOD's mission is the development of technology required to meet any potential military threat in space.

• **Security bind**—Meanwhile, in California, the Air Force invited executives of several aerospace firms to a meeting in Los Angeles to discuss methods of getting more data released about military space efforts. Industry has pressed for a loosening of security requirements which have all but blacked out identification of space programs in company advertising and publicity.

The Air Force invited representatives of Boeing, Thiokol, Convair/Astronautics, Martin, United Technology Corp. and Lockheed Missiles and Space Co. to form an informal committee to study the problem. They will discuss the still-secret security directive issued last March and methods to insure greater freedom of information about military space activities "consistent with the prevailing climate," it was revealed. The committee will draft recommendations to be forwarded to DOD.

Defense research chief Brown himself ran into difficulty with the security requirements in discussing the *Dyna-Soar* program before the Senate committee. He was forced to refer to it as what, in the past, "has been known as *Dyna-Soar*."

He said *Dyna-Soar* is one of the basic building blocks for the technology of space. Although the system never has been accepted as an operational vehicle, he said, DOD is anxious to have the capability for an all-weather, maneuverable, winged re-entry vehicle.

However, he emphasized that DOD has never supported specific military uses for *Dyna-Soar* because "it is not possible to lay down useful military requirements for such a vehicle." ⌗

NASA Now Wants $50-60 Billion by '72

by Hal Taylor

NASA'S SPACE program will cost $50 to $60 billion over the next 10 years—with no downtrend expected once a manned lunar landing is accomplished.

The new estimate of the space agency's soaring budget was made by Deputy Administrator Robert C. Seamans, Jr.

He told a House Appropriations subcommittee that the NASA budget will average $5.5 to $6 billion a year for the next 10 years.

This will mean, Seamans admitted, a total cost of $50 to $60 billion.

Revelation of the huge sum produced no congressional outcry. As one Congressman put it, "We know NASA is here to stay."

NASA's relationship with the Jet Propulsion Laboratory at CalTech, however, did come under heavy criticism. NASA was told not to sign another contract with the university for the use of the laboratory until it had been approved by the subcommittee.

Other developments disclosed by a transcript of a closed-door hearing on NASA's still-to-be budget:

—Space agency officials now believe that the *Nova* first stage must have a thrust of 20 million lbs. This means that 14 liquid-propelled F-1 engines would have to be clustered, the limit of what the Marshall Space Flight Center feels is feasible. Total cost of *Nova* development is estimated at $1.5 to $3 billion.

—NASA's average profit fee paid to industry under its cost-plus-fixed-fee research and development contracts is 6.4%. Actual fees paid have run from 3.41 to 9.35%.

—Total cost of the *Advanced Saturn* is now expected to reach $1.5 billion, and perhaps $2 billion. The five F-1-engine first stage—under contract to the Boeing Co.—will cost $700 million. The five-J-2-engine second stage—under contract with North American's Space and Information System's Division—will cost $500 to $600 million.

—NASA Administrator James E. Webb does not favor amending the Space Act to cut down on the amount of information about the civilian program which can be released.

• **$1-billion jumps**—Testifying on NASA's future funds requirements, Webb told the subcommittee that the NASA budget in Fiscal '64 would jump by $1 billion over the Fiscal '63 request of $3.7 billion. Another $1-billion jump is expected in Fiscal '65, but he said it should then level out between $5.5 and $6 billion per year.

While he admitted that this would mean about a $60 billion total over the next 10 years, he said that expenditures through 1970 would only be $35 billion.

• **JPL attack**—Subcommittee criticism of the JPL setup was principally centered on the $1.2-million management fee which NASA will pay the California Institute of Technology in Fiscal 1963.

After noting that NASA owns the land and equipment and pays the salary of all JPL personnel, subcommittee members questioned whether management services were worth that sum.

They also questioned the propriety of operating JPL under a non-profit contract which permits NASA to pay higher salaries to its personnel than it can pay to its employees at other centers operated under Civil Service.

Subcommittee chairman Rep. Albert Thomas (D-Tex.) then told deputy administrator Dr. Hugh L. Dryden he wanted future contracts with CalTech submitted to the committee. "We just do not like the setup," Thomas said.

The subcommittee still has taken no action on the appropriation bill. ⌘

Union Carbide Bids to Become a Major Propulsion Firm

UNION CARBIDE Chemicals Co. may well join the ranks of major U. S. propulsion firms as a result of its new series of storable liquid and solid propellants.

The firm's high-energy storables are based on a family of novel metal hydride coordination compounds—designated Hybaline—developed during a two-year, company-funded, integrated research program. The Air Force is now funding this aspect of Carbide's effort under a $480,500 contract from the Space Systems Division's Rocket Research Labs, at Edwards AFB, Calif.

• **New structures** — Union Carbide researchers have discovered 36 promising classes of these compounds comprising both liquids and solids. Some may find applications as high-energy fuels, others as additives in solid propellants.

The compounds are new molecular structures and some have been fired by the Air Force in test engines at Edwards. Details of the compounds are classified.

A separate result of the research effort is an original concept of solid-propellant grain structure which increases the sturdiness of the grain and realizes higher energies with state-of-the-art propellants.

The key to this development is in the method of motor fabrication. Union Carbide spokesmen say the process is not a casting method, in the accepted sense of the word, and certain aspects of it are entirely new.

Details of the process were not disclosed, but existing propellant facilities would have to be modified to handle the whole method. Union Carbide has fired 500-lb.and 5000-lb.-thrust motors with the new grain.

• **Process change**—The innovation is not in the ingredients but in the process. The firm says it is using no high-energy additives or ingredients other than currently known compositions.

Dubbed "Firefly," a program of fabrication and test-firing of experimental grains is in progress at the Chemicals Co.'s South Charleston, W. Va. Technical Center. Through related programs in elastomer chemistry, the firm has also developed novel binders which may prove useful in solid propellants because of reported superior physical and ballistic properties.

Present solids testing is being done at the technical center, but Union Carbide owns a 43,000-acre tract about 30 miles from the South Charleston facility. This area could be used for advanced development and possibly for production of the new propellants and additives.

The company is firmly committed to strong R&D programs in the propellant field. New experimental facilities are under construction at the Center.

In addition to Air Force-funded work, Union Carbide is expanding its own programs in both liquids and solids. Qualified personnel are being sought to build up the technical staff, currently numbering about 50. This group is expected to be expanded to about 100 by the end of the year. ⌘

At IAS meeting . . .

One-Man, One-Way Moon Trip Urged

Plan presented as method of winning lunar race; personal shielding called best solar-flare protection

by Willard E. Wilks

Los Angeles—A program for sending a U.S. astronaut on a one-way trip to the Moon has been put forward for serious consideration.

The result would be to push up America's first lunar landing by 1½ to 2 years and possibly beat the Soviets, two Bell Aerosystems Co. engineers told the Institute of Aerospace Sciences summer meeting in Los Angeles last week.

Detailed scientific and technical analyses show that man could be kept alive indefinitely and do valuable scientific work until a vehicle such as *Apollo* is ready to pick him up, John M. Cord, project engineer, Advanced Design, and Leonard M. Seale, chief, Human Factors Section, reported. During this lone stay on the Moon, perhaps for as long as 3 years, the man would be in continuous radio contact with the earth and would be supplied by unmanned cargo vehicles.

"The Russians may already be going that route," Cord told M/R. "We are not necessarily advocating such a mission, but believe it should be given serious consideration. It would be a very hazardous mission, but it would be cheaper, faster, and perhaps the only way to beat Russia."

• **Proposal details**—He made these four points concerning the lunar landing:

—A one-way trip is within the current state of the art, with booster requirements significantly below those for roundtrip missions.

—It would increase the probability of *Apollo* success.

—It could be integrated into current NASA programs, with presently planned lunar probes paving the way.

—It could be expanded into a two-or-more-man mission by sending companion explorers in separate capsules.

The proposal calls for an *Apollo*-like capsule of 2190 lbs. gross weight, requiring an Earth-escape weight of only 6000-9000 lbs., compared to 17,000-30,000 lbs. for roundtrip missions. A booster of 450,000 to 1.1 million lbs. thrust, attainable in 1964-65, would be needed, Cord asserted.

Following the already scheduled probes and fly-bys, unmanned payload landings, and selection of a landing site and placement of a radio homing beacon by robot exploration vehicles, the mission could be accomplished in three steps.

First launch, declared Cord, would be a "boilerplate" version of the cargo rocket to provide a final operational check on all systems. Next would be cargo payload flights with equipment and supplies. About 22 cargo rockets would be required to maintain the one-man base the first year. Landing of the manned capsule would follow after robot television cameras showed that all was in readiness.

Cord outlined these additional features of the spacecraft and proposal:

The cargo vehicles, perhaps 10 ft. in diameter by 10 ft. in length and having a gross weight of 2190 lbs. (including 910 lbs. of cargo), would be using for living shelters.

Protection against solar-flare radiation would be accomplished either by lead shielding delivered in cargo vehicles

Russian Luniks Credited with Fine Target Capability

THE TWO 1959 Russian Luniks—the lunar fly-by and the impact craft—had velocity tolerances of about 0.1%, indicating an excellent targeting and launch guidance capability, says a scientist from the Douglas Missile and Space Systems Division.

K. W. Kiser, guidance and control chief at Douglas, presented the results of an analysis of the Lunik guidance systems to the annual meeting of the Institute of Navigation at San Diego, Calif, last week.

The paper, co-authored with A. H. Gallas, assessed the accuracy of the Luniks despite the blackout by Soviet authorities in such matters. Since mid-course guidance was not used in either attempt, the navigation and guidance must have been completed during the pre-launch and powered portions of the flights.

In the evaluation, Douglas engineers computed two approximate trajectories for the flights and then instigated a study of the effect of rocket burnout error on the desired end-points of these trajectories.

• **Off-the-shelf advocates**—*Two other Douglas engineers told the assembled navigational experts that off-the-shelf economy missiles—stripped of costly guidance equipment not needed on certain missions—might reduce cost of the space program.*

G. C. Goldbaum and H. A. Holman said the more exact control and mission capability would always exist in the more expensive, highly instrumented vehicles but much valuable use could be made of cheaper, less powerful and less sophisticated vehicles.

• **Syncom backup**—*R. W. Cole, a Hughes Aircraft mathematician, presented an on-site back-up to the digital computers to be used by the Goddard Space Flight Center in the Syncom communications satellite program.*

By using a desk calculator and tracking data values as received, and by precomputer matrices of the values, the orbit of the Sycom satellite can be determined. The Hughes expert said the accuracy of the system is within the control capability of the satellite itself, substantiating data computed by Goddard.

Tracking data values will be transmitted via a communications link in Africa to Goddard. Since communications of this type are not infallible, Cole says, prepared techniques for evaluating the necessary parameters will be required in the event of failure.

In this case, only simple arithmetic operations can be considered at a Syncom control site for data processing.

or by covering living quarters with 34 ft. of lunar rubble.

Life support equipment would total 9910 lbs. per year per man, requiring 13 cargo launches.

Cord further suggested that the one-way mission concept also should be studied for Mars and Venus missions.

• **Shielding vs. weight explored**—Personal shielding is the only means of protecting astronauts from solar flare danger during lunar missions if weight is to be held to a reasonable level, a General Electric expert told the IAS audience in another presentation.

Dr. George R. Arthur, of the company's Missile and Space Vehicle Department, pointed out that if adequate radiation shielding were added to the walls of a spacecraft of *Apollo* it would add nearly 3500 lbs., making it impossible for the booster to perform the desired missions.

Personal shielding for three men, however, would add only 1200 lbs. to the basic vehicle weight. Arthur proposed an individual shielding system for each man—employing aluminum, borated polyethylene plastic, and a water blanket.

The astronauts, he said, would pull the quilted water blanket over themselves after putting aluminum and glass covers over their heads. The plastic and aluminum shielding would protect their sides and backs, and slits in the blanket would permit the crew to reach out to the control console.

• **Program weaknesses**—Lack of environmental data for U.S. space programs has been responsible for creating extra steps—significantly increasing program complexity and costs, according to H. M. Segal, Sperry Utah Co. In his paper, "A Critical Path Analysis of Our National Space Program," Segal declared that a critical path can be effective only when quantitative data on space environment can be obtained and subsystems can be tested in a realistic space environment to establish their reliability.

Explorer and *OSO* are fundamental critical programs, he said. *OAO* is an example of a supplementary program—not usually on the critical path.

Segal urged that major *Apollo* subsystems be checked out under actual flight conditions to assure adequate in-flight reliability before the *Apollo* vehicle is launched. To do this will require a special craft to test *Apollo* subsystems in orbit or in outer space.

Subsystem weight has an inverse effect upon the critical path, Segal continued. If weight goals are relaxed, the critical path is shortened—development times are reduced.

He suggested that a budgeting program in a PERT-type array would be an advantage in planning tradeoffs in weight-time relationships. Plotting a hypothetical shield subsystem in weight vs. time for normal and accelerated programs, Segal said the latter should be built in as insurance. If results of Project *Fire* show a 10% increase in reentry heating, an accelerated heat shield development program will be required to meet weight goals, he said.

Proper early planning of a possible accelerated program will result in a new plot which would enable goals to be met—although a penalty for the accelerated program might be higher risk, cost, and possibly a new critical path.

The weight-vs.-time plot has two applications, Segal said. It provides data which can be related at all times to actual-vs.-budgeted performance. Status can be related not only to fabrication, but also to technical progress. And it provides a mechanism for alternative planning and the plotting of alternate critical paths.

• **Unmanned tests costly**—Comparing manned-vs.-unmanned systems, D. G. Starkey, Chance Vought, used the Navy F8U jet and *Regulus-I* missile as examples. In the first 800 flights of each system, Starkey said, there were 3 losses of F8U's against 155 for *Regulus-I*.

The approximate cost of all F8U losses was over $4.5 million against about $66.1 million for the *Regulus*. Although the cost of each missile was slightly less than that of the F8U, overall losses were over 14 times that of the F8U.

It has been estimated, he declared, that had a pilot been aboard, 29% of the *Regulus* losses would have been prevented, for a savings of $19.2 million.

Starkey also pointed out that *Regulus* statistics related only to missiles used for development and training.

Most frequent causes of *Regulus-I* failures were, in order, electronic equipment/communications, boost system malfunctions, fueling system failures, and operator error.

Starkey maintained that the F8U is far more versatile than the *Regulus-I*, is more complex, yet required a shorter development time. It suffered only 2% the number of losses for the first 800 flights—representing a savings of $61.6 million over the *Regulus* program—and required only one-sixth as much time to prepare for each flight.

• **PERT still best**—Commenting upon use of PERT in the *Dyna-Soar* program, T. L. Senecal and R. M. Sadow, Aeronautical Systems Div., Wright Patterson AFB, said PERT techniques should not be legislated but blended into programs by ". . . letting people work with it."

Contractor use of PERT is one of the most important aspects of government implementation of the system, they said, adding that they estimated 60-70% of PERT real value is indicated by contractor use.

"If PERT requirements were dropped by the Air Force from *Dyna-Soar* contracts," they said, "we believe contractors would retain PERT as an in-house operation because of their experience to date." They added: "We are firmly convinced that if PERT is sensibly and reasonably applied to an R&D system, it is the best planning and progress reporting tool the AF has ever used."

In the *Dyna-Soar* program, they stressed, ASD is using 28 reporting networks in its PERT system, including some 4300 events and about 5500 activities. ⌘



'SPACE TRAINER' proposed for astronauts by Ford's Aeronutronic Div. is shown in two configurations. At top, astronaut leaves Gemini capsule and prepares to enter lab. At bottom, spaceman passes directly through modified Gemini fore section into lab.

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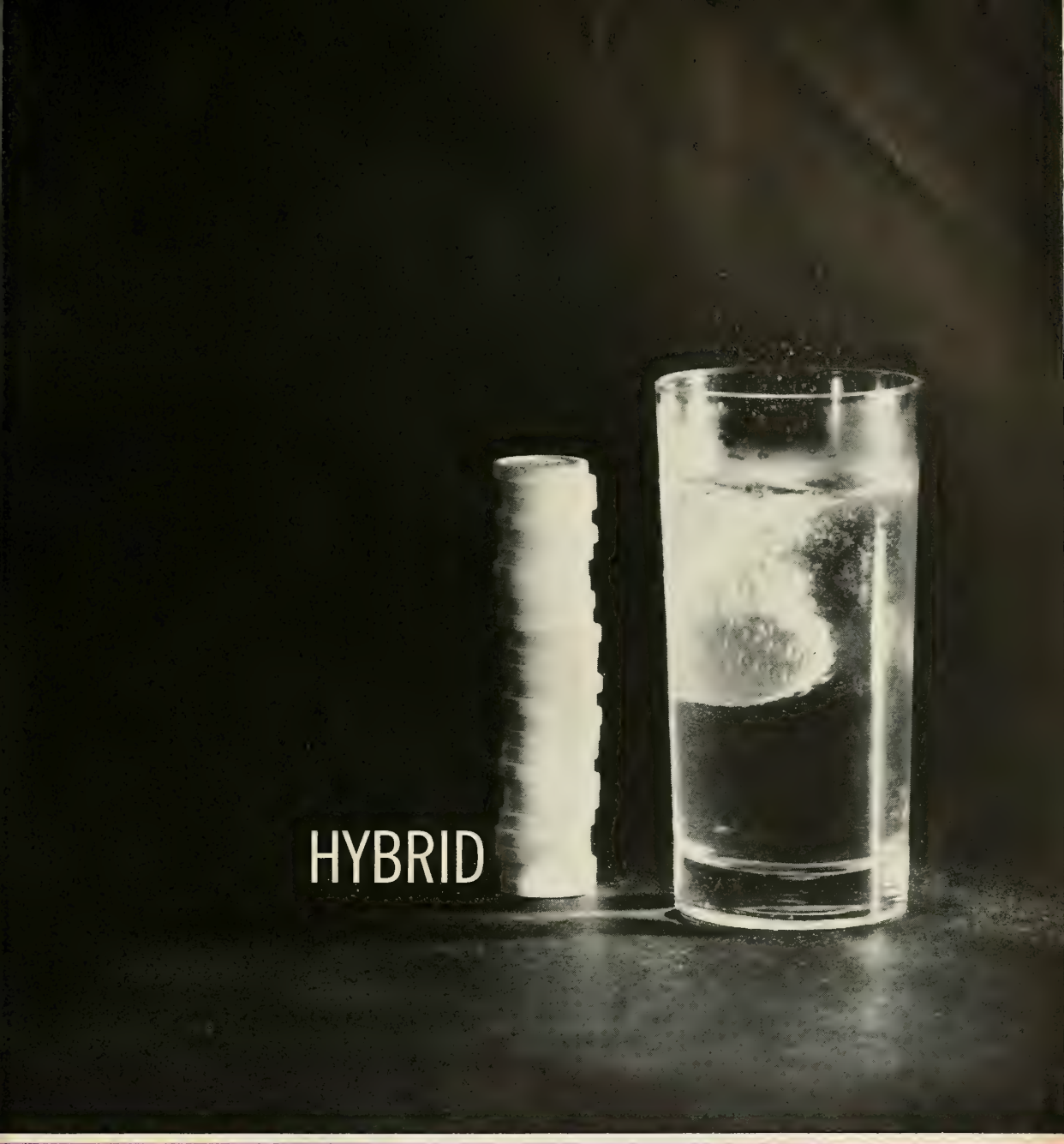
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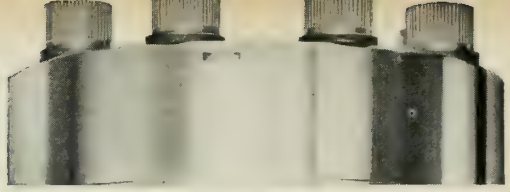
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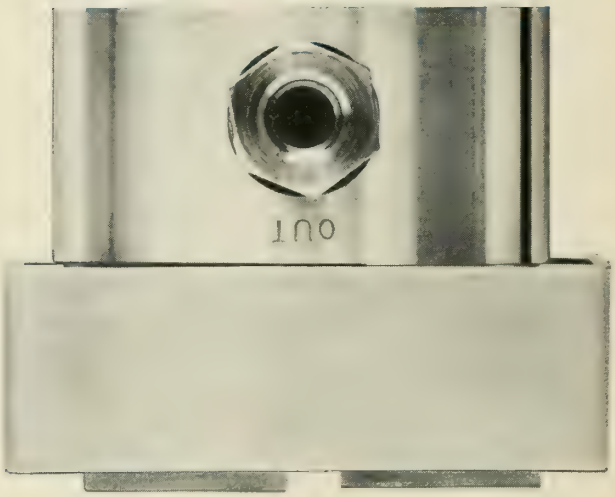
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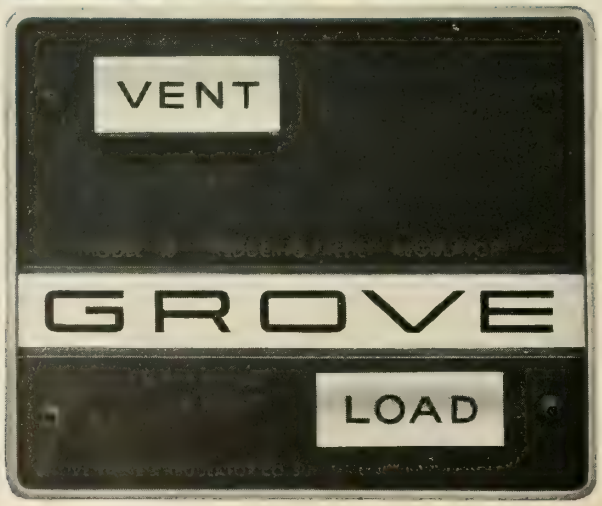
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First Pershing Battalion Activated

Operational deployment, now expected in 1963, to vastly enhance Army battlefield firepower

by Reed Bundy

THE FIRST *Pershing* battalion of the U.S. Army is being activated this week at Ft. Sill, Okla., in a major step toward giving Army field commanders a "Sunday punch" nuclear strike capability.

The new unit will be the 2nd Missile Battalion (Pershing), 44th Artillery. Its authorized strength of 615 men is almost exactly that of a conventional 155 mm howitzer battery, but its firepower will be millions of times greater.

The inertially guided, solid-propellant long-range tactical missile will replace the Army's *Redstone* liquid-fueled standby—doubling *Redstone's* range of approximately 200 miles, vastly increasing flexibility and mobility, and sharply reducing reaction time. The Martin *Pershing* is faster than *Redstone* by a factor of five or six.

Operational deployment of the two-stage *Pershing* probably won't take place until 1963, the Army says, following "some months" of training at Fort Sill and Huntsville. Earlier this year, there were reports that the weapon might be operational before the end of this year. (M/R, Jan. 29, p. 15).

West Germany is expected to have *Pershings* in the field sometime in 1964. West German Defense Minister Franz Strauss announced in Washington recently that his government would buy $120 million worth of the missiles—enough to equip three battalions.

At the same time, Strauss revealed that the Germans were dropping plans to procure $120 million worth of Martin *Mace* air-breathing surface-to-surface missiles.

Activation of the first tactical *Pershing* unit was announced on June 14 by Maj. Gen. Dwight E. Beach, deputy chief of Army Research and Development, who this week succeeds Lt. Gen. Arthur G. Trudeau as chief of OCRD.

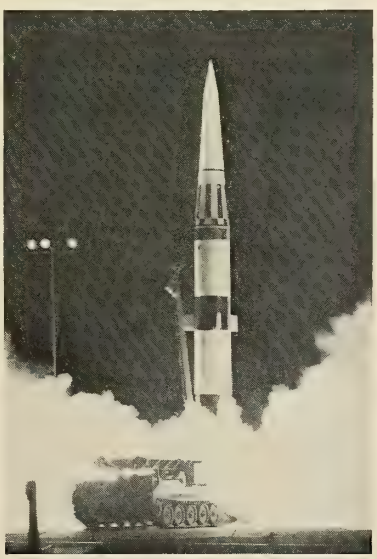
Beach was questioned at a news conference during a day-long *Pershing* press tour which included a trip through the Martin-Orlando plant, where *Pershings* are assembled, a demonstration by an Army *Pershing* battery, and a night launch of a *Pershing* from nearby Cape Canaveral.

• **Batting average dented**—The launch, the 38th in the *Pershing* R&D series, was a disappointment to the Army and the more than 100 representatives of the press and contractor team who watched from a press site 2000 yards away.

The 35-ft.-long missile went through a perfect countdown, lifted off and arched through a perfect first-stage burning. Second-stage ignition occurred as programed, the Army reported, but then there was an immediate loss of power. The missile plunged into the Atlantic a scant 75 miles from the Cape.

The Army later said the *Pershing* had automatically destroyed itself following the ignition. No further analysis of the mishap was forthcoming.

Despite the self-destruct of *Pershing* No. 38, the overall record for the system is still highly superior. Since the first flight-test on Feb. 25, 1960, the missile has compiled a record of 31 successes in its 38 shots. Of the seven failures, four—including the most recent shot—were partial successes.



38TH Pershing launch failed in second stage, but record remains outstanding.

"This proves the R&D program isn't over yet," an Army spokesman observed. "But it's still a great box score."

• **Special demands**—The Army and Martin say the rather long series of R&D shots—described as a "progressive" test program—is necessary because of the special demands for reliability in the system. The *Pershing* approach lays heavy stress on assuring that when the missile is in the hands of combat troops, they can count on its performing every time—and without any danger to personnel.

The first six *Pershings* fired were planned to burn only through first stage. The first two-stage firing took place on Sept. 28, 1960. There was a succession of shots to check components of the control and other systems. The first flight test using integral GSE occurred on March 15 of this year.

In addition to the Cape firings, stringent tests of system components and assemblies are conducted by Martin and its subcontractors, and by the Army at the Army Ordnance Missile Command in Huntsville, at Eglin AFB, Fla., and at the Aberdeen Proving Ground in Maryland.

"We have not taken the bold approach the Air Force has with *Minuteman,*" said Lt. Col. Spencer R. Baen, OCRD's *Pershing* Project Officer. "And we've not had some of the Air Force's troubles—though of course they've done very well."

• **Speed show**—Prior to the June 14 firing, Army troops training with the *Pershing* staged the first public demonstration of how the missile, transported on its four tracked vehicles, is set up and prepared for firing within a matter of minutes.

The entire fire unit is carried on four full-tracked, lightweight XM474E2 missile equipment carriers, a modification of the M-113 standard personnel carrier designed specifically to transport







ABOVE LEFT: *Two of four carriers in unit near firing site. Transportable Erector-Launcher is followed by Programer-Test Station and Power Station.*

ABOVE RIGHT: *Nuclear warhead section (a dummy in this case) is mated to body of the two-stage Pershing. Protective cover is pulled away.*

LEFT: *Missile is raised on boom. Elevation is interrupted automatically shortly before vertical position is reached, allowing for careful seating.*

RIGHT: *Pershing is ready for firing. Boom has been lowered and mast ejected. Battery crew has withdrawn to safe position for launching.*



the *Pershing* system.

The first vehicle in a typical maneuver carries the nuclear warhead—the same warhead manufactured by AEC-Sandia for the Western Electric *Nike-Zeus* antimissile missile—together with a cradle, sling and davit for use in joining the warhead to its missile section.

The second carrier hauls the Transportable Erector-Launcher, produced by the Unidynamics Div. of Universal Match Corp. This unit alone replaces 34 tons of equipment in the *Redstone* system. The missile rides in a horizontal position and is raised to its vertical position by a boom on the vehicle. The launch platform travels in a vertical position and is lowered to the ground, then automatically leveled by the computer.

The missile can be fired from a ground surface ranging from the perfect horizontal to a 20° angle.

The third carrier transports the Programer-Test Station and Power Station. The first of these units provides automatic testing of the missile components and preflights the guidance system. The gas-turbine-driven power station supplies power for the erection operation, the missile batteries and guidance. It also air-conditions the guidance section to within 1°F of the 77° which is ideal for the sensitive guidance components.

Last of the carriers transports the Communications Center (AN/TRC 80), which was especially developed for *Pershing* but may become standard with other weapons. The Army says the long-range tropospheric scatter radio system, produced by Collins Radio, is "tactically immune to jamming." It offers a choice of 330 frequencies.

In the June 14 demonstration, 13 minutes, 55 seconds elapsed between arrival of the carriers at the firing site and the time when the *Pershing* was ready for firing from a foxhole 100-200 ft. away. The crew was slowed down by difficulty with a split bolt on the erector-launcher, however, and an Army spokesman said the same crew had previously run through the drill in under nine minutes.

Both stages of the *Pershing* are fueled by solid propellant supplied by Thiokol Chemical Corp. The second-stage utilizes variable burning, to give the field commander a choice of range. Its self-contained guidance tips the missile over when it reaches the "magic point" in its ballistic trajectory; then it becomes a free-falling object.

The *Pershing* system has been given added flexibility by adapting it to the C-123 aircraft and the Boeing Vertol Chinook (YH-1B) helicopter.

• **Accuracy adequate**—Army officials declined to give a CEP for the *Pershing* at this stage of its development. But they said its accuracy was sufficient to guarantee that it would hit the kind of targets envisioned for it—large troop concentrations, depots, rail or highway junctions.

Other principal members of the *Pershing* contractor team, apart from those previously mentioned, include: AiResearch Manufacturing Div., The Garrett Corp.—gas turbine; Eclipse-Pioneer Div., The Bendix Corp.—inertial guidance and control system; FMC—the XM474E2 carriers; Kearfott Div., Ford Instrument/Sperry—adapation kit and fuze; General Precision, Inc.—hydraulic control systems. ⌗

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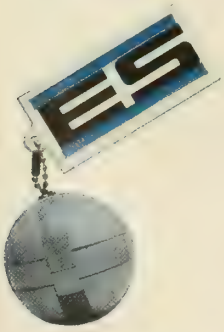
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D-1227 Actuating System—Leading Edge Slat

Type: Limited travel electromechanical linear actuator, mechanically synchronized.
Operating Loads:
Normal operating: 6000 lbs. tension
6000 lbs. compression
In-flight maneuvering: 8000 lbs. tension
8000 lbs. compression
Max. Operating: 12,000 lbs. tension
12,000 lbs. compression
Operating Stroke: 3.15 inches
Operating Speed: 11 seconds max. at 200 volts 480 C.P.S. AC. with normal load applied.
Static Non-Operating: 16,000 lbs. tension
16,000 lbs. compression
(Safety factor on above 1.5)
Operating life: 10,000 cycles at maneuvering load
200 cycles at max. operating load
1000 mechanical disconnect loads
Voltage requirements: 190-210 volts, 320-480 CPS, 3 phase AC.
Current Requirements: 4.6 amp/phase max. at max. operating load.
Limit Switches: Retract limit, mid-position indicator and extend limit—must repeat within .001 inch, 24 to 31 volts DC.
Mechanical Stops: Positive, non-jamming.
Brake: Operates on 24 to 31 volts DC.
Mechanical disconnect: Must mechanically disconnect motor from driving actuator at a pre-set load and withstand 1/2 min. of continued motor operation while disengaged.
One Motor operation: With only one motor operative, the system must function by driving both actuators thru a mechanical interlock with the normal load applied to both actuators.

D-1228 Actuating System—Trailing Edge Flap

Type: Limited travel electromechanical rotary actuator
Operating Loads:
Normal Operating: 0 to 26,000 pound-inches—torque increasing linearly from 0 to 45° travel.
Landing load: 0 to 38,000 pound-inches—torque increasing linearly from 0 to 45° travel.
In-flight maneuvering: 0 to 33,000 pound-inches torque increasing linearly from 0 to 15°.
Max. Operating: 0 to 46,000 pound-inches torque increasing linearly from 0 to 45°.
Operating Stroke: 45° between limit switches
52° between mechanical stops
Operating speed: 13.5 sec. max. at 200 volts—480 CPS with normal operating load applied.
Static, non-operating load: 50,000 pound-inches torque
(Safety factor on above 1.5)
Operating Life: 5000 cycles at landing load.
5000 cycles at maneuvering load.
50 cycles at max. load.
1000 mechanical disconnect loads
Voltage Requirements: 190-210 volts, 320-480 CPS, 3 phase A.C.
Current Requirements: 4.6 amp/phase max. at max. operating load.
Limit Switches: Retract limit, 15° position indicator, and extend limit—must repeat within .001—24 to 31 volts D.C.
Brake: Operates on 24 to 31 volts D.C.

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Technical Countdown

ELECTRONICS

Continuous Guidance Correction Proposed

"Predictive guidance" to permit continuous guidance and control correction of spacecraft between the Moon and Earth would increase landing-target accuracy to within a few miles and reduce travel time to 2½ days, two Martin Co. engineers report. An average speed of 15,000 miles/hour could be maintained on return to Earth, they said in a paper delivered at an Institute of Aerospace Sciences meeting in Los Angeles. Re-entry velocity would be about 25,000 mph. (No mention was made of reaction-jet fuel requirements to accomplish such a mission.)

400-cps Transmissions Successful

Very-low-frequency (400 cps) radio signals were successfully transmitted by Space-General Corp. recently over the 750 miles between Boron, Calif., and El Paso, Tex. Tests were conducted for the Air Force to substantiate the theory that long-range ionospheric propogation could be achieved at low frequencies. A 400-cycle alternator with a 300-kw output was used as a transmitter, with a 2-mile horizontal grounded radiator. A very sensitive mobile receiver and a loop antenna were employed at varying distances to measure the transmission range.

Plasma Sheath Studies Extended

A highly sensitive radiometer has been designed by the Air Force's Cambridge Research Lab to measure the properties of noise generated in the plasma sheath surrounding re-entry vehicles. Essentially a miniature transistorized crystal video receiver, the unit will compare plasma noise with a reference noise source in the receiver in an attempt to find new clues to characteristics of the ionized sheath. The first spaceborne package will operate at 2000 mc, with an input bandwidth of 200 mc and a 1-kc switching rate.

OPTICS

AF To Test New IR Tracker

A new passive infrared missile tracker has been delivered to the Atlantic Missile Range for test and evaluation by the Air Force. Built by Barnes Engineering Co., the dual functioning system employs a 4° x 4° field for rapid target acquisition. Coarse azimuth and elevation error signals are then generated to drive a modified *Nike-Ajax* tracking pedestal at maximum slewing rate and center the target within a 4x4 milliradian field for precision tracking. Tests so far indicate a static pointing accuracy of 0.01 mil rms and a tracking accuracy of ±1%. The Optical Unit uses two 12-in.-dia. reflective telescopes; the Electronic Unit employs immersed lead-sulfide detectors.

ADVANCED MATERIALS

More On Dry-Film Lubricants

Scientists at CBS Labs have run 20-amp currents through power rings continuously over a 15-day period in vacuums of 10^{-8} torr as part of their effort to develop dry-film lubricants for satellite slip-ring assemblies (M/R, Dec. 11, 1961, p. 28). No overall increase in contact resistance was observed. Extremely low coefficients of friction—in the 0.16 range with brush loadings of 150-180 grams—were recorded, and minimal ring damage and wear debris was discernible at the end of the test period.

Laser Welder Now Possible

American Optical Co. has obtained laser pulse lengths of about 20 milliseconds, which may open the door to practical welding applications at optical frequencies. The company's Southbridge, Mass., Research Center reports it used an FX-33 Xenon lamp source with a 0.060-in.-dia. x 2-in. clad rod. A 9¼-in.-dia. sphere was used to couple the image optically between flash tube and laser. Laser input was 1680 joules and the device was operated at room temperature.

Dyes to Help Spot Proteins

A new method of detecting life in space will be developed under a NASA study contract awarded to Ford's Aeronutronic Division. The device, for use on Mars or Venus probes, will utilize certain chemical dyes which change color when brought into contact with protein particles. The resulting change, which would produce the J band (dark blue) of color, could be relayed to Earth in the form of a measurement of how much light passed through the dye solution.

Million-lb. Pressures For Materials Research

The changes taking place in materials undergoing extremely high pressure can be seen visually and directly as a result of a current National Bureau of Standards study aimed at finding out some of the intrinsic properties of materials. Experiments at calculated pressures of 70 kilobars (1 million psi) are being undertaken routinely, and observations at pressures up to 115 kilobars have been made.

PROPULSION

Weather Rockets to Support ICBM Tests

Arcas-Robin weather rockets will be launched from Ascension Island beginning in mid-July in support of upcoming *Atlas-E* and *Titan II* tests over the Atlantic Missile Range. Firings will be performed by Pan American Airways' Guided Missiles Range Division. A mylar sphere, projected from the upper-stage payload into the atmosphere, will contain a corner-reflector antenna to assist radar tracking. Rockets launched 2 hours after ICBM launchings will permit the recording of wind direction and speed, air density, temperature and pressure.

SPACE MEDICINE

Beefed-Up Algae Best

Aerojet-General Corp.'s Dr. Richard Tew reports that the efficiency of algae in producing oxygen can be multiplied by separating CO_2 from the air first, then feeding the concentrated CO_2 to the algae. He says that response to changing CO_2 levels will be accomplished by the concentrating device, simplifying control of the culture by permitting operation at a constant density and dilution rate. Thus the culture system will not have to be oversized to compensate for occasionally high rates of CO_2 production.

ASTRONAUTICS

Balloons May Survey Venus

A NASA advanced planner is pointing out the advantages of using balloons as vehicles to help explore the Venusian surface. Technical reason is that the planet's surface barometric pressure is estimated to be of the order of 10 Earth atmospheres—a medium aerostatically able to maintain substantially greater payloads than the Earth's atmosphere at significantly lower weight.



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New Drone-Formation Control Readied

Used with Q-2A drone, system will aid antiaircraft tests, may be used to calibrate range instrumentation

by Michael Getler

ARMY WEAPON testers hope to have operational this fall a new and versatile drone formation control system which will enable them to test and evaluate a series of antiaircraft missiles against medium-performance multiple-target raids.

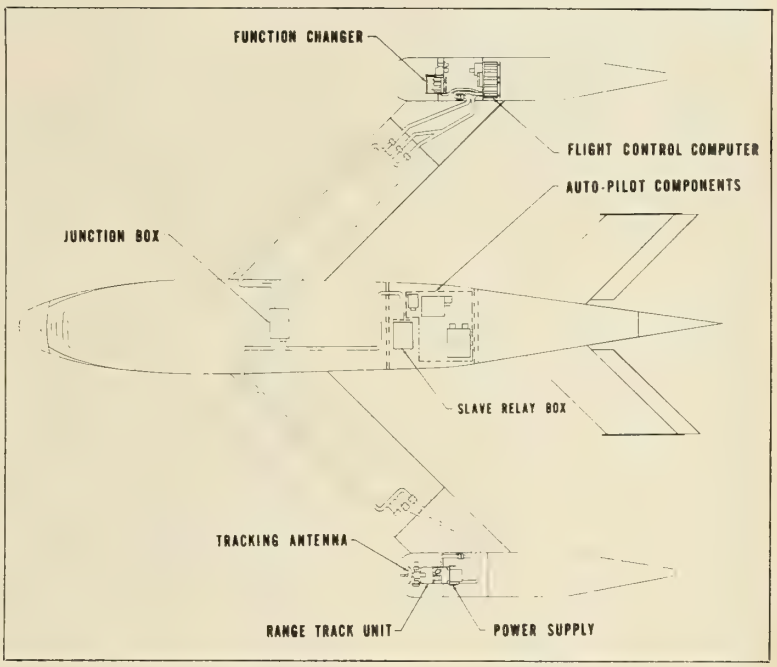
The system, designated FC-17, has been mated with the Ryan *Q-2A* target drone and is now undergoing flight tests at the Army's White Sands missile range. Though initially bothered by some air and ground control difficulties. service officials report they are enthusiastic over recent airborne operations.

Essentially, what the FC-17 will do is provide airborne control of one, two, or possibly several slave target drones in relation to a lead target throughout a wide flight envelope in all-weather conditions—with a ground operator exercising control only over the lead target. In this manner, the Army will have on call a precise target formation, able to keep station automatically through climb, dive, and turn maneuvers, and to make station-keeping corrections.

Transistorized circuitry, modular construction, and use of a Ku-band radar contributed significantly to development of a relatively lightweight and low-power system which could be used with the *Q-2A*. The FC-17 is intended to replace the considerably heavier FC-8 system which is now used with the slower *QF-80* drone formations.

Both the FC-8 and FC-17 systems were developed for the Army by the Unidynamics Division of Universal Match Corp., under the technical supervision of the Army Ordnance Missile Command at Huntsville, Ala.

• **Flight parameters**—According to UMC engineers, the FC-17 is designed to permit formation maneuvers with climb or dive rates to 1500 fpm, and within a 5-mile turning radius. Slant range between targets within the formation can be set between 100 and 1000 ft.; elevation angles for the slave from level flight to 45° down on either side of the lead are obtainable and the azimuth angle extends back to 45° from the wings.



WIRING & EQUIPMENT layout for Ryan Q-2A configured for slave operation. Function changer will be eliminated in operational units, making room for other devices.

Formation velocity, according to UMC, ranges between a minimum of 10% greater than the slowest safe speed and 90% of maximum airspeed, with the 10% margin maintained for error correction. Altitude limitations are said to be basically those of the drone.

Top speed of the *Q-2A* is Mach 0.85; ceiling is listed as 40,000 ft.

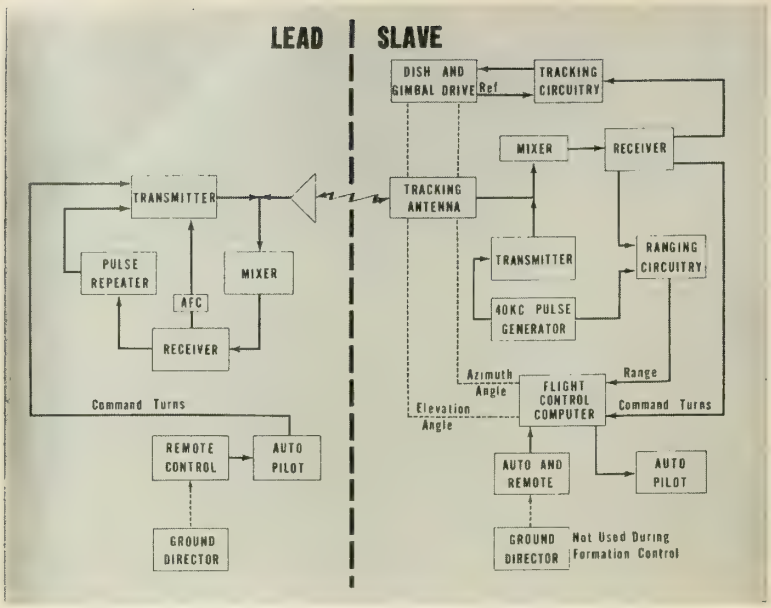
The FC-17 is also said to be compatible with any Category II drone—the type generally described as medium-performance, subsonic with altitude limitations at about 40,000 ft.

Primarily, the drone system is expected to be used to test various missile systems and warhead configurations against individual or multiple targets in a controlled formation. Among the missiles expected to be tested against it are the Army's *Hawk* and *Nike-Hercules* and the Navy's *Talos* shipboard-launched air-defense weapon.

The system is also expected to have other significant missions, including use as a calibration device for the radar and optical instrumentation at the White Sands range. Also, though this is not currently planned, Army officials point out that the device could conceivably see service at nearby Ft. Bliss, Tex., to help train Army antiaircraft missile crews in working against multiple-target raids.

UMC officials also claim the FC-17 concept could be adapted to airborne mine-laying, and paratroop deployment operations.

• **Equipment layout** — All major equipment for the FC-17 airborne operation is carried in the *Q-2A* wing pods.



MAJOR UNITS of FC-17 electronic package in simplified block diagram. Miniaturization, modular construction in UMC system cut weight to one-third of FC-8 equipment.

For the lead target, when operating with a slave drone off the right wing, a transponder is carried in the right pod with a wide-beam fixed-mounted antenna projecting through the outboard side of the pod. This equipment weighs about 15 lbs., occupies 0.5 cu. ft. and requires 30 watts for operation. The same equipment can be installed in the other wing pod for simultaneous operation of a left slave. The weight, volume, and power requirements for the lead target in the FC-17 show a considerable drop over the 62-lb., 1.5-cu.-ft., 220-watt system used in the FC-8.

For the slave, a position detector and power supply are carried in one wing pod, and a flight control computer and function changer are aboard the other pod. However, the function changer will be removed after flight trials are ended, and, in an operational configuration, the computer can be carried in the same pod as the position detector and power supply—leaving the other wing free for augmentation with scoring equipment, target enhancement devices, or ECM gear. The basic equipment for the slave weighs 55 lbs., occupies 1.9 cu. ft., and requires 150 watts.

Briefly, the FC-17 in flight determines the relative position of lead and slave in slant range, azimuth, and elevation, compares the data with the desired pre-set position, computes any out-of-formation errors, and applies corrective signals to the throttle and autopilot of the slave.

Provision is also made for loss of slave control, perhaps through missile damage. In this case, a circuit within the slave's computer terminates control and injects signals which will fly the craft clear of the formation.

Most of the electronics within the system are used to gather: first, relative position information; second, control data to fly the craft into proper position.

• **Position detection**—Actual formation parameters are measured by position-detection circuits consisting of a transponder in the lead target and tracking electronics in the slave.

Slant range is measured by the elapsed time required for a pulse signal to go from the slave to the lead and return. A range pulse generated in the slave modulator serves to change slightly the frequency of the Ku-band klystron on the tracking antenna. A high-gain antenna concentrates this signal in the direction of the lead.

The transmitted signal is received by the lead's antenna and klystron, converted to a 60 Mc IF signal with a short-duration frequency shift caused by the range pulse, and amplified by an eight-stage amplifier. The IF AGC amplifier maintains a constant output magnitude over the expected variation of the signal input level.

A pulse amplifier then amplifies the range pulse from the IF amplifier and generates a new noise-free coincident range pulse. A modulator in the lead controls the average frequency of the lead klystron to maintain the required 60 Mc separation from the incoming slave frequency.

Consequently, the lead antenna transmits a Ku-band cross-polarized signal 60 Mc different from the slave's, and containing a small frequency shift produced by the repeated range pulse.

After amplification in the slave receiver, the returning range pulse is sent to a range detector. The elapsed time between the slave modulator trigger input to the range detector and the repeated pulse from the slave amplifier gives a direct measure of the distance between the lead and slave, with a microsecond delay approximately equal to 500 ft. in range.

Azimuth and elevation angles are measured directly from the slave antenna tracking gimbals.

• **Position control**—The flight control computer is the major component associated with position control, providing three separate control signals for the throttle, ailerons, and elevator of the slave.

Range scaling is obtained by converting the d-c range signal from the position detector in a 400-cps modulator, and amplifying the resulting a-c signal in an isolation amplifier. Output from the amplifier, coupled with the azimuth and elevation resolvers, provides the three necessary signals resolved into stabilized rectilinear displacements.

Signals representing actual and desired longitudinal separation are then compared in a difference amplifier, with any error amplified. The error signal then passes through a phasing network and a channel amplifier to the existing *Q-2A* throttle controller.

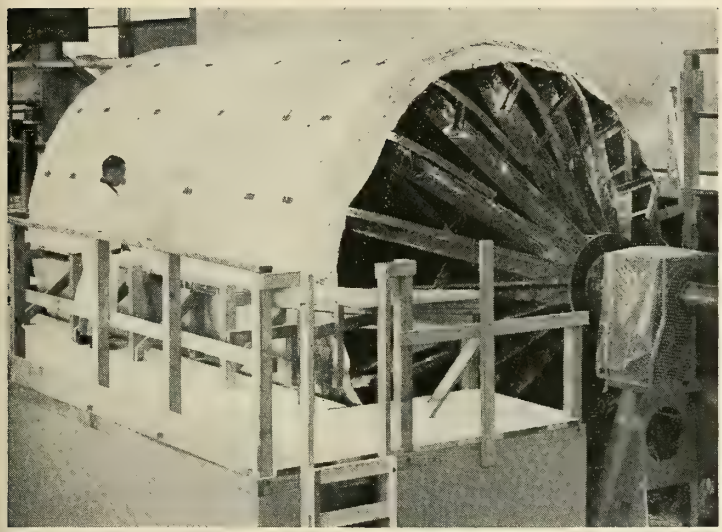
In a similar manner, error signals in the lateral and vertical channels are obtained and passed through phasing networks and channel amplifiers which feed the correct signals to the autopilot for controlling the aileron and elevator surfaces.

In both the aileron and elevator channels, signal limiting is built into the channel amplifier to set the maximum amount of error signal fed to the elevator and aileron actuators. As a result, the maximum pitch and roll angles are limited to a value less than those possible through remote override from the ground.

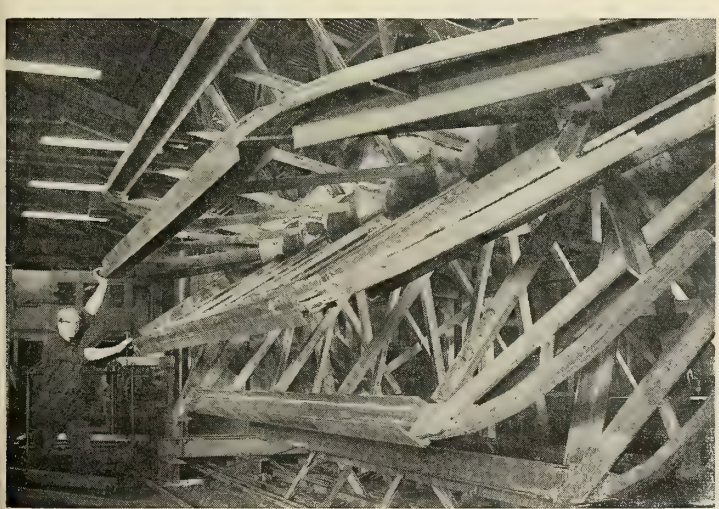
Stable and accurate formation control, UMC engineers point out, requires additional throttle stabilization. Therefore, a signal proportional to the rate of engine change is added to the longitudinal error signal; this anticipates the rate of error closure and allows corrective action to be taken sooner to reduce overshoot. The signal is also cross-coupled to the elevator channel to compensate for the change of lift with thrust caused by the inclined angle of the jet engine. ■

Hercules Builds Biggest Filament-Wound Case

by John F. Judge



HUGE SIZE of mandrel necessitated building this platform for application of plaster layers. Flat stud plates hold down reinforcing wire screens.



STEEL FRAMEWORK precision-welded to basic arbor is so well balanced it can be turned by hand. Each supporting frame is an exact distance from mandrel center.

THE LARGEST filament-wound solid rocket motor case in history is rapidly nearing completion at the Rocky Hill, N.J., facility of Hercules Powder Co.

The massive experimental pressure vessel will have an outside diameter of 13 ft., a length of 25 ft., 2.5 in. and will weigh 20,000 lbs. About 9600 lbs. or 240 million miles of glass fibers will be used.

The chamber is designed for a 1200 psi minimum burst with a composite hoop stress of 85,000 psi. A combination of helical and 90° windings will provide the required longitudinal-to-girth strength ratio, taking into account the given internal pressure.

Forward and aft integral end closures will be generated entirely by the helical windings, which reverse around the metal fittings and retain them under pressure loads. End closure cross-section will be of a precise pattern to provide uniform stress throughout the structure. Closure configuration is generally elliptical in shape.

A low carbon steel case of comparable size and based on an assumed minimum tensile strength of 70,000 psi for the metal would weigh about 5 times the glass case. A joint efficiency of 85% is also assumed for the steel chamber.

Size is another factor in steel—flanged and dished one-piece heads are not fabricated as a standard item with an outside diameter of 156 in. These large heads are made in sections and welded, introducing more weld area into the case.

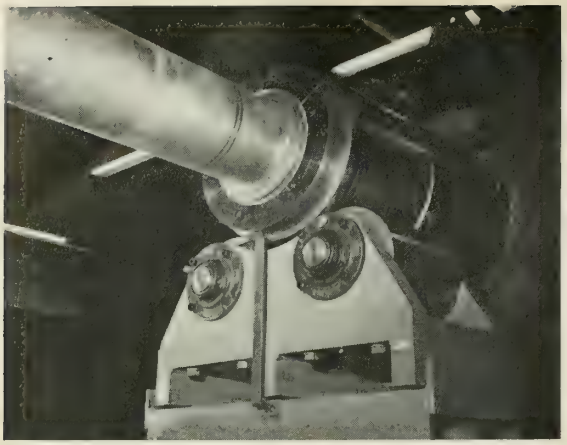
Steel polar fittings will be used on the massive Hercules case, primarily because of the cost factor and expediency in the delivery. The strength of such fittings can be accurately determined and this aids in providing maximum insurance for the testing of the Spiralloy case.

The polar fittings will account for approximately 27% of the total case weight. Further weight improvements can be achieved by substituting aluminum and the savings can be applied towards increasing the payload.

The huge fittings were specially made for the chamber using a doughnut shaped forging. This piece was flame-cut into the two desired sections after the forging operation and chamfered to reduce the machining process. Heat treating alone took 20 days, followed by 15 days of machining.

The fittings have an ID of 5 ft., an OD of 7.16 ft. and each weighs 2780 lbs.

• **Design innovations**—The mandrel itself consists of 16 steel frames mounted on a heavy steel core. The core is machined to bearing-surface quality



MACHINED SURFACE of mandrel core acts as a bearing. The two large rollers are in turn resting on smaller rollers. The index arm is an aid in fabrication.



TECHNICIANS POSITION plaster pattern board before applying final layers. The saw-tooth edge assures that radius will be constant before the smoothing operation.

at both ends and rests on a set of roller bearing designed by Hercules experts.

The mandrel is designed to transmit the weight to the ends of the core, and the machined ends rest on two large roller bearings which are themselves supported by smaller rollers. This cuts down the effect of the weight on individual bearings.

From the steel framework out, the mandrel is built of successive layers of plaster with wire-mesh reinforcement. When completed, the rubber insulation will be applied and several layers of glass fibers will be dry-wound around the mandrel to tighten the unit.

Hercules expects the actual winding operation to take about two weeks. The glass used will be Owens-Corning. Fiberglas roving ECG #140, 20-end with the HTS finish. The epoxy resin system will have low temperature cure characteristics.

About 30,000 gal. of water will be needed to hydrotest the case.

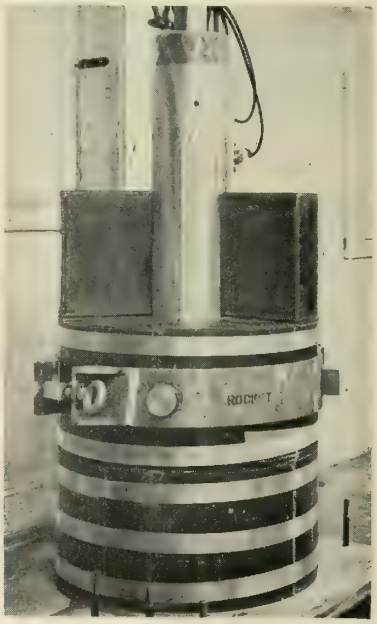
• **Booster building method**—The 13-ft. motor case is part of Hercules' step-by-step plan to prove the feasibility of scaling up glass wound pressure vessels to big booster dimensions. Hercules experts are relatively unimpressed with their own work so far. They point to industrial tanks much larger than the cases under consideration being filament wound as a matter of course.

Years of familiarity with glass winding in solid rocket applications bolster their contention that scale-up is not the problem critics make it out to be. Even the 13-ft. chamber hardly reaches the potential of the equipment already in operation at the Rocky Hill facility.

The scepticism which greeted the announcement of their on-site, pie-segment big booster technique (M/R, Oct. 16, 1961, p. 14) never equalled that of their own designers and engineers when they initially considered the idea. This was quickly replaced by enthusiasm as hard years of experience in both glass winding and propellant handling were brought to bear on the concept.

The glass-sector technique—which simply involves building giant boosters by stacking pie-shaped segments to any desired height and then wrapping the entire structure in glass fibers with room-temperature curing resins—passed its first verification with the firing of a small 9-sector motor.

The unit was hand built by stacking small propellant sectors and then filament-wrapped. The ignition phase was normal and a steady thrust of 30,000 lbs. was achieved over the full duration of the test.



A SMALL 9-sector motor was hand-built with these grain sections, filament-wound, and successfully fired. The unit achieved a steady 30,000-lb.-thrust level over the entire test.

The case was in excellent condition after the firing, verifying every design feature of the concept.

The glass-sector technique evolved from a Hercules effort to find an approach to booster fabrication which would eliminate size as an inherent characteristic. Size is completely independent in this approach.

The firm faces the same arguments as other major solid proponents. The prime problem is that the entire rocket industry is based on performance acceptance—physical demonstration of proposed concepts—and almost all industry propellant experts regard this as an idiotic way to handle large solids.

Hercules propellant specialists point out that multi-grain charges are the oldest in the book. Reliability is designed and built into the sectors. The ballistics of the sector equal the ballistics of the motor. Even "catastrophic" bond failure of a sector would show up as only a 2% increase in the thrust of a booster formed with 40,000-lb sections.

And a void would have had to be as big as a basketball before detection on a pressure/time trace, says one specialist.

Hercules is not primarily interested in propellant production in this case. The glass-sector technique is a fabrication method designed to take advantage of the country's solid propellant processing capability. Any firm capable of composite propellant manufacture could supply propellant to fuel a booster of any size without transportation problems.

Hercules could fire a 400,00-lb., glass-sector, 260-in. diameter motor within 12 months. This unit would have to overcome every problem in the technique expected in big boosters. ■

3 engineers...and why they moved to Honeywell

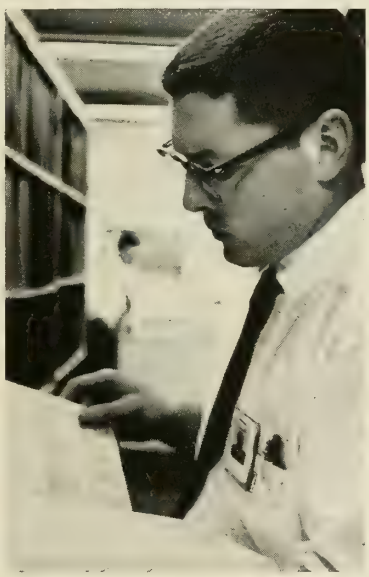
Arthur Langlieb, Senior Development Engineer,

and formerly of New Jersey..."I was most attracted by the apparent high level of professional work being done at Honeywell. I have since found that with my experience, I am encouraged to spend as much of my time as possible doing purely technical work—the kind of thing I want to do most! This minimizes the amount of non-technical work that the company feels can and should be done by others."



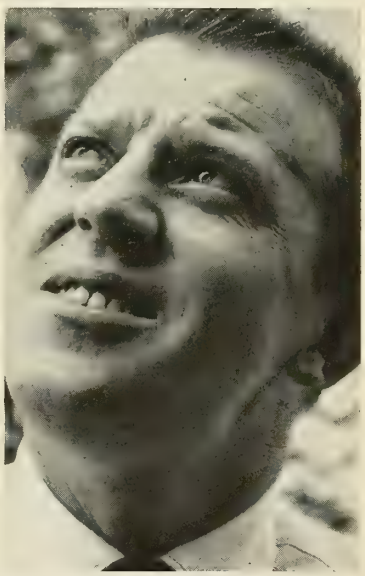
Jim Bass, Computer Data Processing,

and formerly of California . . . "One of the most important reasons I came was the knowledge that I could continue my education as I worked. And once I arrived in Minneapolis I was happy to find that not only was the University of Minnesota only ten minutes away, but Honeywell also encouraged me to go on with my schooling on a tuition-reimbursement basis! ...another reason was the small work groups. You don't feel like a number."



John Brewer, Senior Development Engineer,

born in Minnesota, and recently from Los Angeles . . ."For one thing, my family missed the four seasons we have out here . . . but more importantly, I suppose, was the fact that I wanted to work for a company I knew was foremost in controls in the U.S., and I wanted to have some control over what I designed and developed. To stick with a project from start to finish—to nurse it along—this Honeywell wants me to do."



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THE LONELIEST MEN

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It is outer space.

Already, man has taken the first steps into space. And in the coming years he will reach farther and farther into space, traveling thousands of miles, living for days and weeks and even months in an alien environment.

The success of these journeys is one of the greatest challenges in the history of American industry. It has given the word "reliability" a depth of meaning it has never known before.

Indeed, the reliability demands for space travel are staggering. To assure a 99.9%



chance of return, a space traveler must have equipment whose mean-time-between-failures is 1000 times the expected length of the flight. This means that on an 8½-month trip to Mars the vehicle would have to be built to last more than 700 years.

Certainly no one is more aware of these immense reliability requirements than the engineers and scientists of the aerospace industry. Time after time they are called on to assure reliability in systems that have not even been designed. And time after time the desired reliability has been there when needed.

These unrelenting efforts by the aerospace industry are helping the Free World's astronauts in their conquest of outer space. They are helping the loneliest men on the loneliest job in the world today.

North American Aviation is at work in the fields of the future through these six divisions: Atomics International, Autonetics, Columbus, Los Angeles, Rocketdyne, Space & Information Systems.

C&C Systems Face Constant Updating

Litton's Bosch tells AFCEA mobility and automation can maintain U.S. security

by Charles D. LaFond

MANNED COMMAND and control systems in space and an integrated nationwide complex of dispersed, survivable C&C systems will come into being during this decade.

But the ultimate in sophistication in the 1960's will be attained with U. S. short-reaction-warning defensive and offensive systems.

These predictions were made by Eugen I. Bosch of Litton Industries, Inc., during a panel discussion at the recent Armed Forces Communications and Electronics Association conference in Washington (M/R, June 18, p. 33).

Bosch, the final speaker of a four-man Litton panel discussing "Command and Control for Survival," is manager of advanced systems design, Data Systems Division.

• **Systems obsolescence**—It is safe to predict, said Bosch, that from time to time there will be fundamental qualitative changes in the basic military threat, as well as significant changes in C&C state of the art. And these, of necessity, force drastic updating of C&C systems.

For example, he pointed out that the development—or even proof of feasibility—of a militarily effective "death ray," and the loss of control of outer space without a corresponding defense, would generate an urgent need for new C&C systems to preserve our security.

Evolutionary changes in system design can be handled readily through built-in equipment flexibility, he said, but revolutionary change through technological breakthrough can only be anticipated through educated speculation —sometimes without any apparent sound reasons for prediction.

Manned military space systems fall in this latter category, Bosch asserted. It is reasonably safe to guess that such systems will exist within the decade, but even the particular applications are still in doubt.

In discussing the future C&C survivability needs, Bosch maintained that the most effective approach in mobile systems is through the use of aircraft. He predicted an ever-increasing move by the military toward the use of airborne systems as a means for effective dispersal.

These systems, he said, could be tied to each other and to existing ground networks to provide a very widely dispersed C&C and communications system. Such an approach would help assure a retaliatory capability following a massive first strike by aircraft or missiles.

Finally, Bosch urged complete integration of superior and subordinate lateral command networks with weapon and sensor systems.

He said that automatic data extraction and correlation methods and other new techniques could reduce response time and minimize human error in making critical command decisions. While man may always remain in the loop, there would in the future be many advantages derived from automatic decision-making.

In this search for useful "thinking machines," Bosch noted that three avenues of attack are being followed: pattern recognition theory, neuron or brain simulation, and self-organizing computer programs.

The latter is the more promising approach, Bosch declared, and the first truly self-organizing computer program will be written during the next ten years.

This, he asserted, will bring about an explosion of artificial intelligence and, ultimately, lead to the development of completely automatic C&C systems.

• **At the exhibit area**—AFCEA exhibits this year, according to the consensus of regular attendees, offered fewer new systems than had appeared in previous years. Whether this was the result of tightening purses or current security problems was not known, but no new systems were represented in the military exhibits. (The Air Force demonstrated a model of the Ballistic Missile Early Warning System; the Navy showed its scale-model ships used for antenna R&D; and the Army concentrated on a portable field radar and a field facsimile set.)

Of the more than 180 exhibits, these were a few of the more notable:

—*By Sylvania*—A completely solid-state microwave transmitter and receiver designed for use in a synchronous communications satellite. Developed for the Air Force, the cigarette-carton-size transmitter operates with 2 watts output power in the 1700-2300 mc (S-band) range.

—*By Raytheon*—A 35-lb. transistorized, single-sideband transceiver for field use. Known as the RPS-100, the compact back-pack has an output of from 50-100 watts and achieves a minimum range of 25 miles. The set operates in the frequency range of 2-12 mc in 1-kc increments (providing a choice of 10,000 digitally tuned channels). The unit is powered by a 10-lb., clip-on silver-cadmium battery pack. The latter has a built-in converter for recharging from a vehicular 18- or 24-volt system.

—*By General Electric*—A cutaway model of the ion-exchange membrane fuel cell being developed for NASA's *Gemini* spacecraft. Capable of producing up to a peak load of 2 kw dc, the system also produces a by-product of pure water at a rate of about 1 pint/kw-hour. The oxygen-hydrogen conversion system operates at 60% thermal efficiency under normal load.

—*By ITA Electronics Corp.*—An unusual data recorder using inexpensive 9-in. plastic discs. Capable of recording over an entire 24-hr. period on one disc, the unit operates at 2 rpm with a frequency response from 300-3500 cps. (The actual recording method is an embossing process: the record unit induces a supersonic voltage to vibrate the stylus, which in turn heats the disc just enough to soften it and make an impression.)

—*By Smith-Corona*—An electronic teleprinter with a standard speed range of 60-400 words/min. and a capability of up to 10,000 wpm (line-at-a-time printing). Developed by the company's Kleinschmidt Division, the Model 311 is now undergoing evaluation testing by the Signal Corps. The machine can handle incoming signals with up to 45% distortion without error, developers say. Fully transistorized, the unit weighs 55 lbs. ⠿



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$15 million in FY '63-'64. . . .

How NASA Funds 'Far Out' Studies

by William Beller

THE FUTURE Projects Office of NASA's Marshall Space Flight Center proposes to spend about $15 million during the next two fiscal years for contracted research on an exotic line of projects including planetary transportation systems and operations in the Martian environment.

Much of the money will be earmarked for studies of post-*Saturn C-5* launch vehicles and orbital systems; another relatively large chunk—$2.4 million—will be used for studying lunar base-construction and operations, according to present plans.

The large aerospace companies in the past garnered most of the FPO's system study contracts. This is not apt to change. Marshall says that the chief reason is that personnel from the large companies usually are highly qualified and have long experience in the fields under study.

FPO's mission is to coordinate all Center efforts in developing and evaluating plans and proposals for advanced systems and future launch-vehicle programs. To do this work effectively, the FPO tries to look into the 1970-1980 decade to see what space missions and payloads will be needed.

• **Economics of space flight**—The launch-vehicle pattern drawn by the FPO for this decade: operational capability for 10-ton orbital payloads *(Saturn C-1)* by 1964, increasing to 100 tons *(Saturn C-5)* by 1967, and 200 tons *(Nova)* by 1969-1970. This is a two-orders-of-magnitude increase over to-

(Continued on page 45)

Proposed Contract Funding for Projects Planned by Future Projects Office of Marshall Space Flight Center

(in thousands of dollars)

VEHICLE SUBSYSTEMS	FY '63	FY '64
Electrical and electronic system-design manual for advanced space vehicles	100	100
Self-sustained powerplants in the 1-mw to 10-mw range	—	200
Nuclear-propulsion-system design manual for conceptual design of advanced space vehicles	100	100
Engine design requirements for reusability and very long lifetimes	100	100
High-performance engine study		200
LAUNCH VEHICLES		
Launch-vehicle operational analysis	300	200
Light Launch Vehicle (Reusable vehicle in the 5-ton payload class)	200	100
Medium Launch Vehicle (Reusable orbital carrier vehicle in the 10-ton class as follow-on for Titan III and Saturn C-1)	200	400
Large launch vehicle:		
a. Reusable orbital carrier vehicle in the 50- to 100-ton class as follow-on or derivative of Saturn C-5 vehicle	400	400
b. Paraglider study for C-5	100	300
Very large launch vehicle (Post-Nova class with more than 200 tons of payload with emphasis on escape missions)	200	600
Super Launch Vehicle (Vehicles in payload class of more than 1000 tons to escape, such as Orion)		200
Operational advanced nuclear third stage (Phoebus power density in the 4000- to 8000-mw class)	100	200
ORBITAL SYSTEMS AND ORBITAL OPERATIONS		
Orbital-systems integration	300	350
Hydrogen tanker vehicle	100	100
Mark II space laboratory (Non-rotating space laboratory and orbital launch support facility compatible with Saturn C-5)	100	200
Mark III space station (Rotating space station for about 30 to 50 personnel, compatible with Nova and SNAP 8)	100	400
Orbital facility complex (Required for support of multiple-satellite system operation plus support of lunar base and planetary expeditions)	-	200
Orbital personnel taxi	—	100
Orbital maintenance and construction vehicle	—	100
Orbital rescue vehicle and interorbital ferry	100	100
Orbital maintenance capsule	100	100
Space-vehicle/human-engineering design manual	300	500
General space-vehicle/space-environment simulator facility	100	250
LUNAR TRANSPORTATION SYSTEMS AND OPERATIONS		
Advanced lunar transportation systems (Operations analysis and systems definition)	200	200
Flight-performance manual including orbital operations	50	50
Advanced chemical orbital launch vehicle (For direct cargo delivery in connection with Saturn C-5)	100	—
Expendable nuclear ferry vehicle (RIFT Derivative)	100	—
Reusable nuclear orbit-to-orbit ferry vehicle	200	200
Lunar shuttle vehicle (Chemical, orbit-to-surface-to-orbit)	100	100
Advanced cargo supply carrier (Post-Nova Class, direct transfer, expendable)	200	300
LUNAR BASE-CONSTRUCTION AND OPERATIONS		
(See M/R, June 18, p. 24)	400	2400
PLANETARY TRANSPORTATION SYSTEMS AND OPERATIONS		
Operations analysis and systems definition	—	100
Flight-performance-and-trajectory manual	100	100
Early manned planetary/interplanetary expedition	200	100
Advanced electrical ferry vehicle for planetary missions	100	100
MARTIAN SYSTEMS AND OPERATIONS		
Systems requirements and integration	—	100
Flight mechanics in the Martian gravity (Field and atmosphere)	—	150
Orbit-to-surface shuttle vehicle	—	100
Manned surface-roving-vehicle for Mars	—	100
Mars-Earth return vehicle	—	100
Manned air-breathing exploration vehicle	—	100
Space-carrier-vehicle for Mars base supply with direct entry	—	100
Earth-orbit to Mars-orbit vehicle (Advanced nuclear Phoebus and beyond)	—	100
TOTAL	**4750**	**10,000**

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The Case Against Merger



STEHLING

Editor's note: Members of the American Rocket Society and the Institute of Aerospace Sciences soon will be asked to vote on the proposed merger of the two technical societies. Very little publicity has been given to the views of those who oppose the merger. One of the more outspoken opponents has been Kurt R. Stehling, well-known Planning and Evaluation Staff Scientist at NASA. To present the opposition case, MISSILES AND ROCKETS *interviewed Stehling, who emphasized that these are his personal viewpoints.*

Q. Do you believe that fewer meetings and better papers will result from the merger?

A. Emphatically no! A merger will not reduce the pressure by many individuals to present papers. A unified organization will have, in fact, so many committees and sub-organizational structures that no foreseeable efficient program management is possible.

Q. Won't meetings be combined, thus reducing the number?

A. Some consolidation of meetings might accrue from a merger. But think of the unwieldy size of these meetings! The ARS alone can hardly handle the main annual meetings now. These no longer are personal, easy-to-comprehend meetings, but rather have the appearance of a State Fair. A combined societies meeting would look like a World's Fair.

But, at any rate, the national meetings would be the only ones that could be consolidated (although impossibly unwieldy). The sectional, regional and specialist meetings would merrily go on proliferating as before.

Q. Couldn't better meeting coordination and paper subject presentation be achieved by closer cooperation (without merger) between the ARS and IAS?

A. Again—emphatically YES. Just because so little in this direction has been done before is no reason to have a really serious try at it now. Why shouldn't it be possible for reasonable men (even if they are program chairmen) to work together to prevent too much paper duplication?

Q. Do you feel that the IAS has an alien approach to the principles and ideals of the ARS?

A. I do feel that this is the case and I am safe in saying that Dr. Herbert Friedman of the NRL shares this viewpoint and has, indeed, independently and ably presented it. The ARS presently fulfills its function ably and well and has an enthusiastic, lively membership growing by leaps and bounds (in contrast to the IAS's decline in membership in 1961).

Q. Do you agree with local D.C. comment that the merger is being rushed and being accepted as a fait accompli?

A. I agree, with reservations. Of course, with able men like Bill Pickering and E. Root spearheading the merger—both having great managerial capacity—the merger is bound to be effected quickly and efficiently.

However, I think that we rustics out here in the provinces have not had a chance to speak out on a national level, or even to comment. It is true that letters are being or will be published (re the merger) in the ARS-IAS house organs. Unfortunately, these letters will be rather late, for any influence on the voting by ARS members or Directors.

I believe also, that the positive viewpoint (positive in the views of the merger protagonists, that is) has been unduly stressed, with little opportunity for other discussion.

Q. Do you believe economic and organizational benefits will result from a merger?

A. No major economic benefits will accrue to the members. Overhead has a way of rising out of proportion to the growth of an organization. There probably will be demands for a new building costing millions of dollars. We, in this country, have gone building-mad—we tend to equate shiny concrete and glass boxes with efficiency and intelligent application. The members will not get better publications. They surely won't want more publications. There is hardly enough time to read what is being published now.

The IAS members may delude themselves by believing their fees ($25) will be reduced to the ARS $20 level. I maintain that the joint fees will be $25-$30 within 18 months. Advertising revenues will not increase—why should they when there is only one society and no competition among journals?

Furthermore, I can say especially that there is no virtue in bigness (except salary) and the thought of an antediluvian behemoth of a society, with a half-baked mixture of airplane and space people, is hair-raising.

Finally—what is wrong with a little competition among societies? Aren't they really business—in a sense? Didn't this country grow on "free" competition? ⁂

(See editorial, page 66)

NASA Future Projects

(Continued from page 40)

day's payloads.

One possible flaw in this pattern is the present slowing down on *Nova*, under study for upgraded thrust.

Each of the launch vehicles is a two-stage, expendable rocket to low Earth orbit, and a three-stage to escape velocity. For the escape mission, these vehicles will carry about 40% of their orbital payload when chemical stages are used, 75% if nuclear stages are used.

Here is the expected reliability picture: after 10 research-and-development flights, two successful missions out of three attempts; two years later, three successful missions out of four; two more years later, four successes out of five.

By the end of this decade, the direct operating cost—vehicle procurement, propellants, ground transportation and launch operations—based on the described vehicles, payloads and reliabilities, will approach $150/lb. to carry cargo from the Earth's surface into a low Earth orbit.

The cost is said to increase tenfold when the payload is delivered to the Moon. A nuclear third-stage, however, is expected to reduce the cost to about $600/lb.

In the 1970's, when the state-of-the art progresses beyond the *Saturn* and *Nova* concepts, the FPO predicts that the specific transportation cost for orbital and lunar trips can be improved up to a factor of five.

• **Earth-to-orbit systems**—The FPO says the time will soon come when "one-shot" launches—the most costly way to get a payload into orbit—must be abandoned in favor of a ferry vehicle that can be used a hundred times or more. The reusable vehicle is thus seen as the key to economical operations to and from Earth orbits.

The liquid rocket would be better than a solid one for the reusable ferry vehicle, the FPO maintains. The argument is based on the relative costs of the propellants, "a dominant factor for vehicles with high reusability rates." The solid engine is obviously not even in the running, the FPO says, "when one considers the fact that solid propellants cost $1/lb. and liquid propellants $0.02/lb. to $0.05/lb. or for high-energy liquids, up to $0.25/lb."

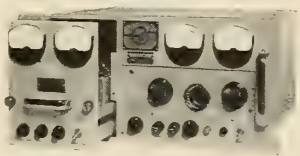
• **Lunar transportation**—The lunar round-trip will most economically be made in three stages, according to the FPO: a chemical-reusable-rocket-aerospace plane to Earth orbit, a reusable nuclear ferry from Earth orbit to lunar orbit and back, and a chemical lunar cargo and personnel shuttle between lunar orbit and lunar surface. ⌘



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Shape Factor (6-60db) . . . as low as 2.5
Demodulators—AM envelope detector, Foster-Seeley FM discriminator, FM Phase—Lock Detector except on wide bandwidths.

Circle No. 24 on Subscriber Service Card

The Industry Week

Labor Bill Change Urged

A Congressional sub-committee has been told that a "thorough overhauling" of the Davis-Bacon Act is needed to speed construction and trim costs of missile bases. (The 1931 Davis-Bacon statute was originally enacted to protect construction companies conforming to proper labor standards from unfair competition within the industry itself.) Douglas V. Dorman, Martin Marietta Corp. vice president, presented the views of the Aerospace Industries Association to the Special Subcommittee on Labor of the House Education and Labor Committee, which is studying a proposed revision of the Act. He told the subcommittee that although the Act was never intended to give a competitive advantage to unions in the construction industries, as against unions in the manufacturing industries, or enter jurisdictional disputes between unions, it has functioned in this manner in many cases. He said obstacles the Act placed in the way of the missile program stem mainly from the fact that it does not clearly specify where construction ends and installation, operation and maintenance of items in the structure begin.

DOD Names Defense Council Members

The Defense Department has named 21 industry members to the Defense Industry Advisory Council, set up in May of this year to provide better communication between DOD and industry (M/R, June 4, p. 10). In a statement accompanying his invitations to industry leaders to join the Council, Deputy Secretary of Defense Roswell Gilpatric noted that "the pace of technological breakthroughs and the compression of development and production cycles have given rise to sharp changes in Department of Defense methods of planning, budgeting and contracting, and have had profound effects on many segments of industry and areas of the economy." Members of the council are: Thomas V. Jones, President, Northrop Corp.; E. C. Burkhart, President, Genisco Inc.; Walter F. Carey, President, Automobile Carriers, Inc.; Ruben F. Mettler, President, STL; Charles B. Thornton, Chairman of the Board, Litton Industries, Inc.; Stephen A. McClellan, President, Specialties, Inc.; James R. Kerr, President, Avco Corp.; John R. Newell, President, Bath Iron Works; Charles Hastings, President, Hastings-Raydist, Inc.; E. V. Huggins, Chairman/Exec. Comm. and VP, Westinghouse Electric Corp.; Dan A. Kimball, President, Aerojet-General Corp.; Lynn A. Townsend, President, Chrysler Corp.; Thomas S. Nichols, Chairman of the Board, Olin Mathieson Chemical Corp.; E. W. Rawlings, President, General Mills, Inc.; George F. Ferris, Chairman of the Board, Raymond International, Inc.; Ely R. Callaway, Jr., Executive VP, Burlington Industries, Inc.; David A. Shepard, Executive VP, Standard Oil of New Jersey; Dr. Dening Lewis, Communications Systems Research, Bell Telephone Labs; James McCormack, VP, Defense Labs, MIT; William M. Allen, President, The Boeing Co.; Morehead Patterson, Chairman of the Board, American Machine and Foundry Co., Inc.

News of Mergers and Acquisitions

Kawecki Chemical Co. acquired Accurate Specialties Co., Inc., Hackensack, N.J. Accurate, to operate as a wholly owned subsidiary, manufactures products for producers of electronic components, including alloyed and clad metal preforms, ceramic tooling for high-temperature processing and metallized ceramics. Kawecki produces and supplies rare metals and their compounds to the electronic and metallurgical industries.

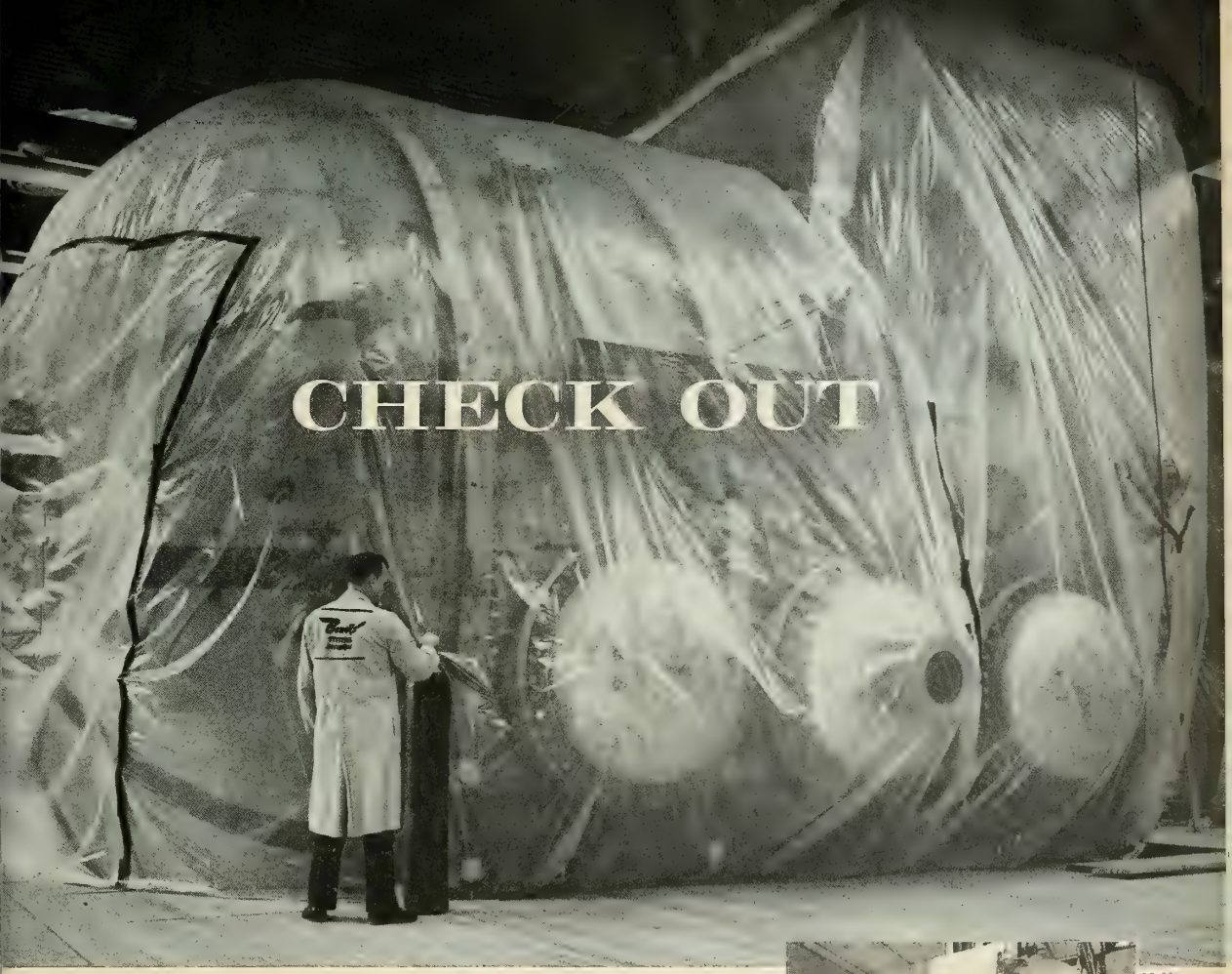
New Industry Facilities

Ryan Aeronautical Co. is building a Systems Dynamics and Simulation Building in San Diego. . . . *Designatronics, Inc., has centralized operations in its Mineola, N.Y. plant. The company manufactures and distributes electronic and electromechanical products.* . . . Permacel has built a new distribution center in New Brunswick, N.J. The company makes pressure-sensitive tapes, electrical insulating materials and adhesives. . . . *Air Reduction Sales Co. plans to build a multimillion-dollar liquid air separation plant in Beaumont, Tex., to serve a nearby Du Pont plant and other area industries. The facility will have a production capacity of 130-tons-per-day of high purity oxygen, nitrogen and argon.* . . . Melpar, Inc., is transferring its Applied Science Div. from Watertown, Mass., to the company's recently completed research facility in Fairfax County, Va. The company plans to expand the division's staff and programs. Transfer is expected to be completed by Oct. 1. . . . *HRB-Singer, Inc., is building a new production facility in State College, Pa. The building will contain an underground tunnel for testing infrared photomapping equipment.*

New Names in The Industry

Space Ordnance Systems, Inc., was formed in El Segundo, Calif., to research, design, engineer and manufacture explosive ordnance devices for the aerospace industry. Facilities include research and quality control labs, prototype and production machine shops, explosive blending and storage bays, production and assembly areas, test cells, and offices. President is William R. Dickie. . . . *Aero Vac Corp. was formed in Troy, N. Y., to conduct research and development in vacuum technology and produce ultra-high vacuum chambers and components. Walter R. Nial is President-Treasurer.* . . . Central Systems Corp. is the new name for recently-merged Brook Labs Co., Inc., and Central Coil Corp. The combined company produces electronic systems for military and proprietary electric and electronic equipment for industry. . . . *Airpax Electronics, Inc., Decco Div., has been renamed the Pacific Div., and moved to new facilities in Northridge, Calif.*

Circle No. 18 on Subscriber Service Card →

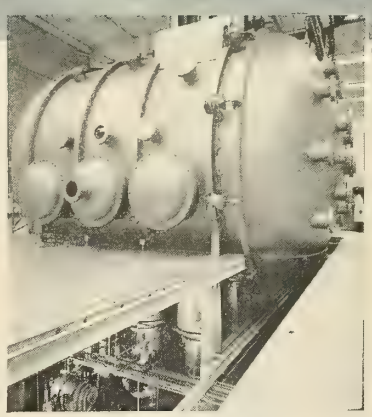


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The contract specifications for a 20 ft. dia. by 30 ft. space environmental testing chamber, recently completed by CB&I for Bendix Corporation Systems Division, Ann Arbor, Mich. called for altitude simulation up to 800,000 ft.

But when CB&I checked it out before placing it in operation, the chamber delivered an impressive 1,300,000 altitude feet – a 500,000 ft. bonus! The final test was made by sealing the chamber in a giant polyethylene cocoon filled with helium to detect any possible leaks. Then for eleven hours the chamber was pumped down to 4.8×10^{-8} mm Hg and held there for several hours.

Here is evidence, again, of how well CB&I designs, engineers, fabricates, builds and places in operation space-simulation systems for the nation's space program. It pays to call on CB&I design ingenuity and fabricating and construction skills. A "world of experience" awaits your inquiry. Chicago Bridge & Iron Company, 332 South Michigan Ave., Chicago 4, Ill. Offices and subsidiaries throughout the world.



The Bendix space simulation system includes the 20 ft. dia. by 30 ft. chamber, fabricated from stainless Hortonclad,® six 32 in. dia. diffusion pumps, two 2,000 cfm rotary blowers and four rotary piston pumps, furnished in collaboration with NRC Equipment Corporation. CB&I was the prime contractor.

Another CB&I Environmental Chamber



New Product of the Week:

Automatic Cable Testers

A PORTABLE cablemaster 400 B available from Accurate Electronics Corp., will measure insulation resistance, dielectric strength (hipot) and continuity of bulk cable, cable assemblies and connectors, and can automatically check up to 400 circuits. It will measure insulation resistance to 5000 megohms and dielectric strength to 3000 volts on either a-c or d-c current. Multiple circuits are also automatically sensed on the cablemaster eliminating the need for patchboards or jumper plugs.

The unit will meet or exceed the testing requirements of applicable military specification. It can be operated unattended, stopping itself when a fault is discovered. An audio alarm system alerts operating personnel regardless of their proximity to the unit.

Circle No. 225 on Subscriber Service Card

Positive Climbing Belts

An additional sleeve has been introduced by the Safety Tower Ladder Division of Air Space Devices for its Saf-T-Climb structural safety equipment. Over 2 lbs. lighter and 6 in. shorter, the sleeve provides a tensile strength of 110,000 psi compared to the previous model's 65,000 psi. Designed to give workers positive climbing safety on any vertical structure, the device can be attached even where no climbing provision exists.



The sleeve employs a positive-locking mechanism that engages into the notches if a climber applies weight in any other manner than the normal climbing position. No special equipment or provisions for installing are required; bolt-connecting or welding brackets are available for most structures.

Circle No. 226 on Subscriber Service Card

Environmental Chambers

Corona Manufacturing Corp. is marketing its Super Six Eighteen line of environmental chambers to include cold and humidity chambers.

Based upon the accepted six eighteen insulated box principle, all of these chambers utilize common components and basic dimensional relationships.

Optional air-flow patterns and a complete range of control options (including ±0.25° solid-state proportioning silicon controlled rectifier) afford over 25 different selections to match individual needs.

Circle No. 227 on Subscriber Service Card

VLF Receiver/Comparator

A VLF receiver/comparator which determines the frequency error of a local standard by comparison with standard national signals of NBA and WWVL has been developed by RMS Engineering, Inc.

The solid-state, completely self-contained system is designed for standardizing the frequency of the local frequency standard having drift rates from 1 part in 10^7 per day to less than 1 part in 10^{10} per day. The overall sensitivity of the system—which includes a compact, high-performance ferrite antenna—is such that NBA (18kc) or WWVL (20kc) can be received at most



any point on Earth.

Designed as Model LF-18-20/B, the instrument contains a TRF receiver, synthesizer, and phase comparator. Continuous comparison is permanently recorded on a self-contained strip recorder.

Circle No. 228 on Subscriber Service Card

Ultra-Fast Laser Detector

An ultra-fast solid-state photodiode for laser detection and other applications has been developed by CBS Laboratories.

The C-P 1 laser detector, which can be operated from a flashlight battery, is a silicon-diffused, planar, surface-passivated light sensor designed for low leakage currents at high reverse bias and for ultra-fast response time. It is packaged in a TO-18 transistor enclosure with a hermetically sealed flat glass window.

Circle No. 229 on Subscriber Service Card

Silicon Rectifier

Universal Rectifier Corp. has introduced the "c" series of hermetically sealed, high-density ceramic rectifiers for printed circuit and other close-quarter mounting. Developed for high reliability applications, these six new types have an operating temperature

(Continued on page 54)



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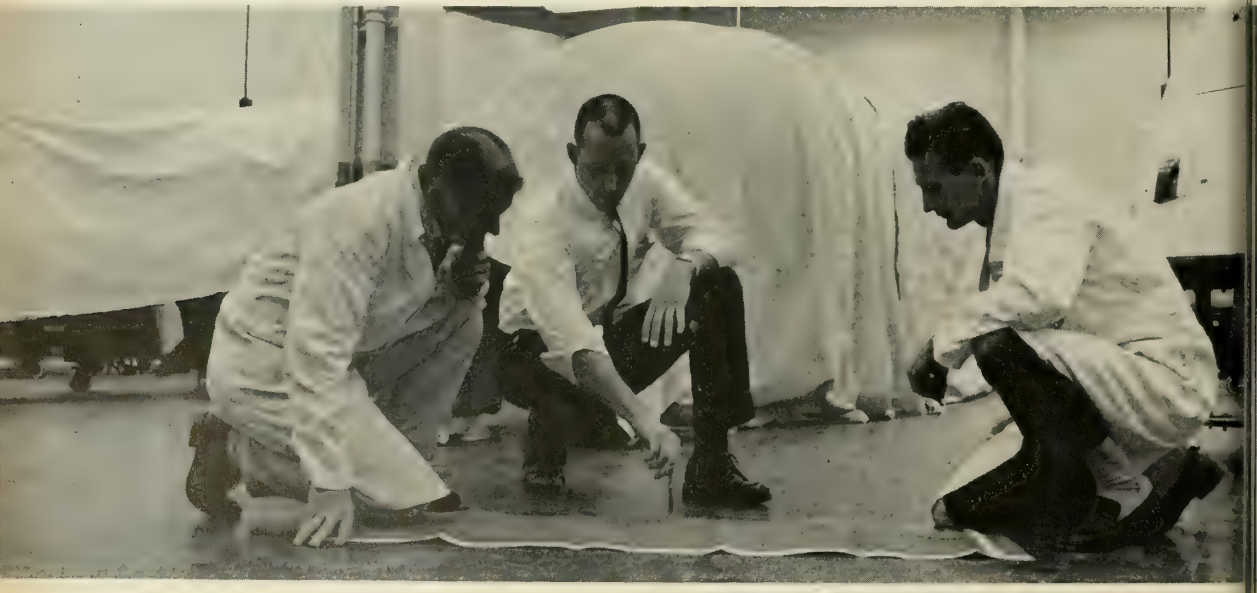
THE BIG PICTURE

at Lockheed Missiles & Space Company

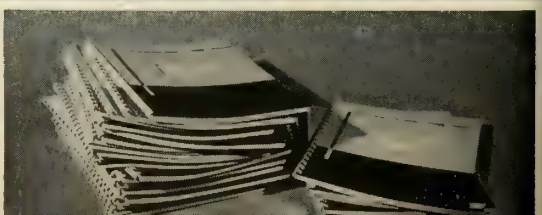
The urgency of today's major weapon and space projects has given rise to a new science of management. Its basic premise: in order to meet an absolute deadline, manufacturing must get underway while research, engineering, and testing are still going on. This management philosophy has been employed with notable success at LMSC on critical Air Force, Navy, and NASA programs.



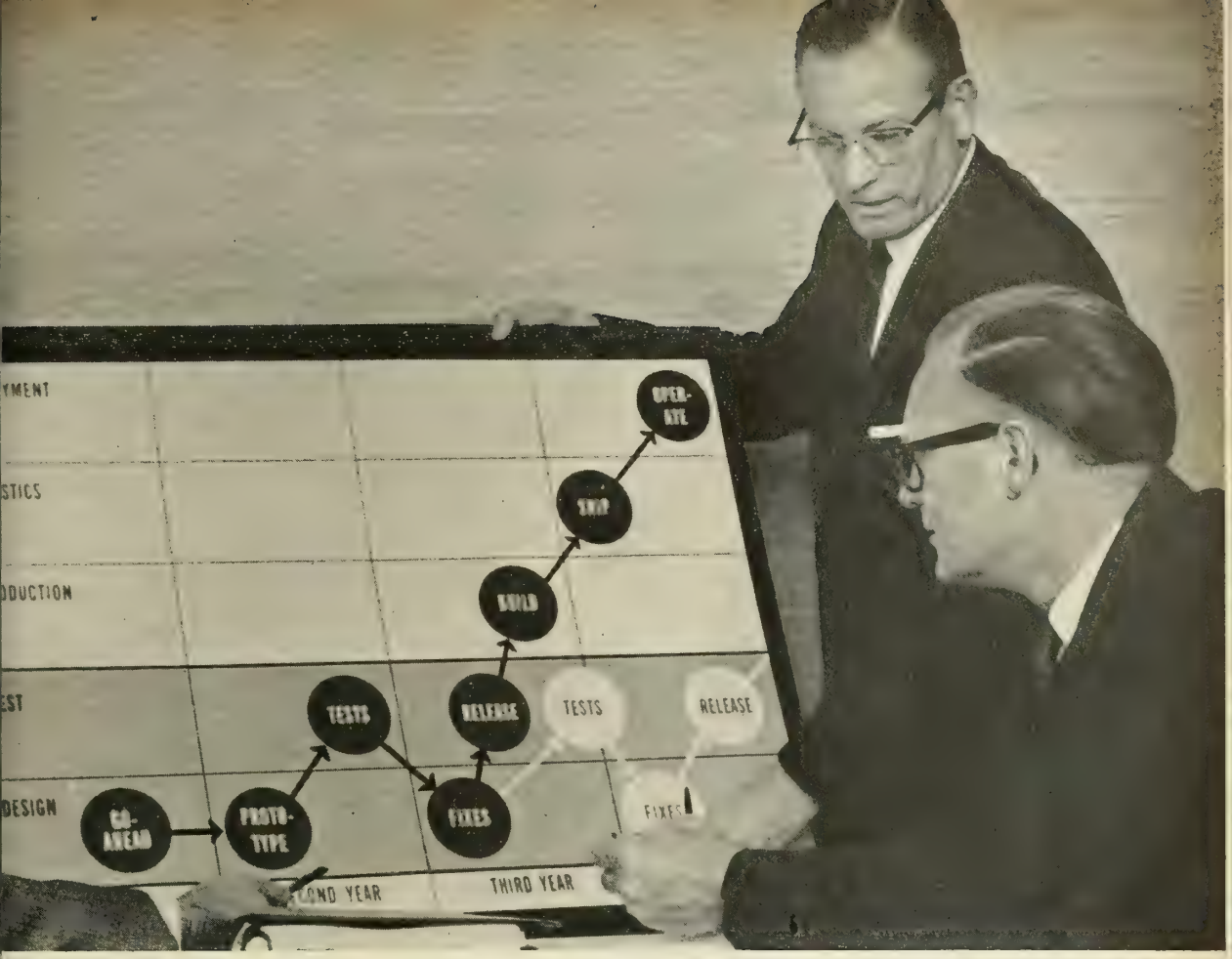
Complex projects are carefully preplanned by LMSC management (right). Schedules can be shortened by starting several phases of a program at the same time instead of in sequence.

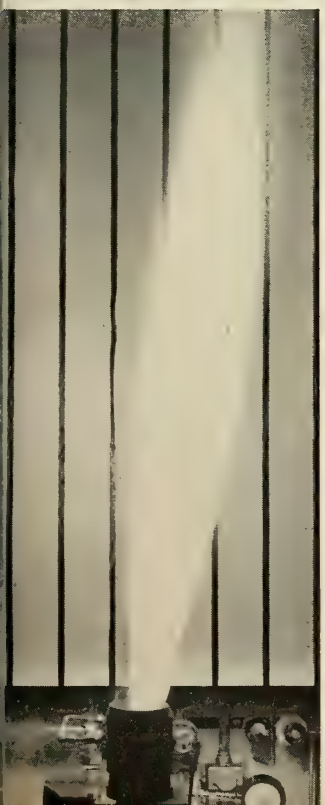


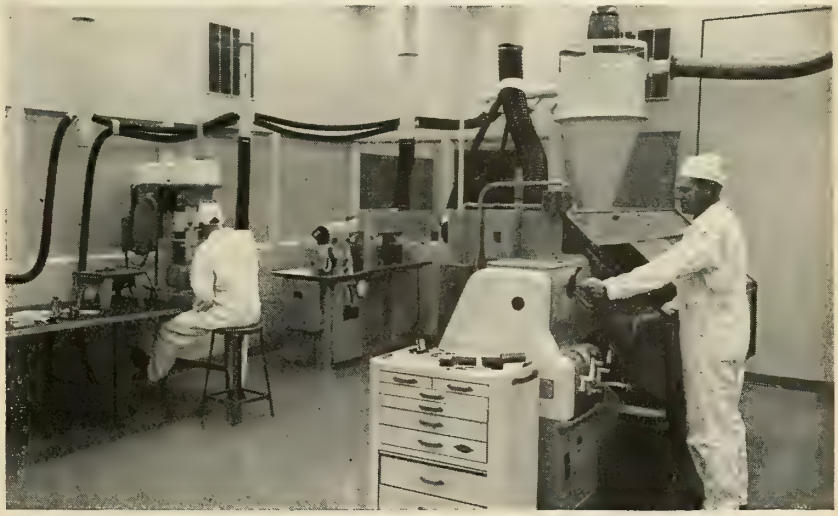
Lockheed project planners (above) can accurately predict the cost of future weapon and space systems, both in dollars and in elapsed time, by applying these new management techniques.



New management methods compress paperwork. Before-and-after photo (right) shows how number of reports required from a typical subassembly section in one 6-month period was reduced.







Swift pace of major programs requires research problems to be solved on schedule. Typical of the scores of R&D projects at LMSC are the processing of high temperature Space Age materials such as beryllium and pyrolytic graphite (above) and steering a missile by deflecting its rocket exhaust with a fluid injection of cold gas (left).

Lockheed Missiles & Space Company, Sunnyvale, California is a group division of Lockheed Aircraft Corporation.

Your Place in APOLLO

. . . at AVCO/RAD

Addition of the vital Apollo Heat Shield to Avco/RAD's Minuteman, Titan, Atlas, and Penetration Aid program has created new opportunities for Senior Scientists and Engineers qualified in the following areas:

★ STRUCTURES ENGINEERING

Structural Design Methods
Structural Loads
Structural Analysis
Dynamic Analysis
Structural Testing
Solid Mechanics

★ THERMODYNAMICS AND HEAT TRANSFER ENGINEERING

Ablative Heat Shield Design
New Ablation Theory Development and Design Procedures
Material Thermal Performance Evaluation
Preliminary Design

★ AERODYNAMICS DESIGN AND DEVELOPMENT

Aerodynamics Analysis
Performance-Trajectories-Dispersion-Stability
Vehicle Dynamics
Aerodynamic Loads
Wind Tunnel Testing
Preliminary Design
Configuration Optimization
Heat Transfer

To support these activities the Division's 23 million dollar facilities, located just north of Metropolitan Boston, has recently added a new space research laboratory to simulate conditions encountered by vehicles returning to earth after lunar and interplanetary missions.

Featuring facilities such as an MHD shock tube and molecular beam shock tunnel to accelerate gases to 60,000 feet per second, the new addition extends the Division's capability to offer scientific and technical personnel the proper atmosphere and equipment to carry out assigned and future programs.

Send resume to
Mr. J. Bergin
Dept. JS

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Circle No. 25 on Subscriber Service Card

(Continued from page 48)

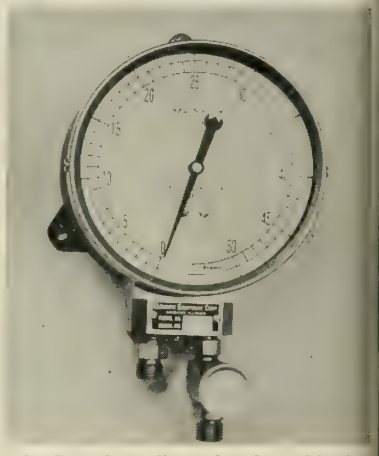
range from −65°C to +175°C with P.I.V. ratings from 200-v through 800-v. Size of these low-leakage rectifiers is ⅛-in.-dia. by ⅜-in.-long; overall length 3¼ in., with .031-dia. axial tinned copper leads.

The ratings of these uints are forward current 750 ma, surge current 30 amps.

Circle No. 230 on Subscriber Service Card

Inert-Gas Flow Meter

An electron-beam materials processing system is available from Electron Heating Corp. The system blanks off in a low 10^{-8} torr range and is designed for operation in the low 10^{-7} ranges. A simplified control set-up permits operation by semi-skilled personnel. Complete dimensional positioning of the beam in the X, Y and Z axis are included, as well as automatically regulated control of emission current. The system is capable of programed evaporation of semiconductors, alloys and glasses while retaining stoichiometry on substrate deposits.



Circle No. 231 on Subscriber Service Card

S-Band Transponder

Aero Geo Astro Corp. has available a lightweight, high-power superheterodyne radar transponder for target, missile and space vehicle application.

Designed the AGA S/T Model 303, the transponder operates over a frequency range of 2700 to 3000 megacycles and is available with transmitter outputs of 500 to 2500 watts. Weight has been held to 6.5 lbs. and volume to 115 cu. in.

Circle No. 232 on Subscriber Service Card

Low-Noise Traveling Tube

GL-8154, a low-noise traveling wave tube for use in the 7-to-11 kilomegacycle frequency range, is available from General Electric Co.

The metal-ceramic tube designed



keep in track

WITH MOTOROLA'S QUALIFIED INSTRUMENTATION

A complete line of radar transponders and command receivers is now available from Motorola for off-the-shelf delivery. Designed and built to meet the tracking and control requirements of a wide variety of missiles, rockets, drones, manned aircraft and space vehicles, this compact instrumentation is setting new standards of performance and reliability. Typical are Motorola's subminiature, solid state, C-band transponders, conservatively specified for maximum reliable operating life under the most severe environmental conditions. Designed for reliable, high-precision tracking by multiple radars at extended ranges, these transponders feature high power and superior sensitivity. And they are also available in S and X band versions. If you are interested in performance specifications on any of Motorola's qualified transponders or command receivers, write to our Instrumentation Products Group today.

AN/DPN-66 Superheterodyne Transponder
Power: 500 watts. Sensitivity: −70 dbm
Size: 200 cu. in. Weight: 10.8 lbs.

SST-131 Microminiature Superheterodyne Transponder
Power: 400 watts. Sensitivity: −65 dbm
Size: 40 cu. in. Weight: 3 lbs.

AN/DPN-71 High Power Superheterodyne Transponder
Power: 20 Kilowatts. Sensitivity: −75 dbm
Size: 0.3 cu. ft. Weight: 28 lbs.

SST-114 Subminiature Crystal Video Transponder
Power: 50 watts. Sensitivity: −42 dbm
Size: 55 cu. in. Weight: 3.5 lbs.

AN/DRN-11 UDOP (UHF Doppler) Transponder
Power: 3 watts. Sensitivity: 5 μV
Range: Input 430-470 mcs (Output 2x) Weight: 10.5 lbs

MCR-100 Series Radio Command Receiver
Channels: 10. Sensitivity: 5 μV
Range: 406-450 mc. Weight: 2 lbs. 15 oz. (max.)

MCR-300 Series Radio Command Receiver
Channels: 3. Sensitivity: 5 μV
Range: 406-450 mc. Weight: 2 lbs. (max.)

MCR-400 Series Radio Command Receiver
Channels: 4. Sensitivity: 5 μV
Range: 406-450 mc. Weight: 3 lbs. 13 oz. (max.)

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Military Electronics Division **MOTOROLA**

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NASA

NASA Office of Manned Space Flight

CAREER APPOINTMENTS IN

Project Management

Vehicles & Propulsion Directorate

The Vehicles & Propulsion Directorate seeks to appoint engineers and scientists to positions of unusual responsibility. The duties inherent in these positions will have a direct and material bearing on the nation's manned space flight programs.

More specifically, the selected applicants will participate in the top level planning and implementation of NASA activities relative to large hydrogen-oxygen booster and spacecraft engines and large launch vehicle stages. You will direct, control and evaluate the programs assigned to NASA field centers, university laboratories, and private corporate contractors as well as prepare long range plans in the launch vehicle and propulsion areas.

Respondents must have at least a BS in ME, EE, aeronautical or chemical engineering and several years' experience in rocket propulsion and/or launch vehicles. Experience in project management or supervision is also required.

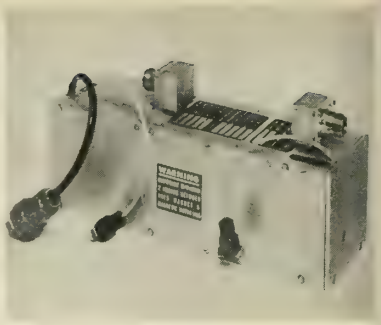
SEND RESUME IN CONFIDENCE TO:

DIRECTOR OF MANNED SPACE FLIGHT, DEPT. 133

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

WASHINGTON 25, D. C.

ALL QUALIFIED APPLICANTS WILL RECEIVE CONSIDERATION FOR EMPLOYMENT WITHOUT REGARD TO RACE, CREED, COLOR, OR NATIONAL ORIGIN.



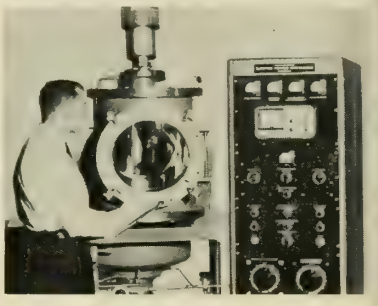
for input service in radar receivers, has a noise figure less than 10 db, minimum gain of 25 db, and power output of 5 milliwatts across the entire band. It withstands shock of 50 g's and vibration at 5 g's.

Additional uses for the GL-8154 include applications in radio astronomy; radiometry, countermeasures and microrelay systems.

Circle No. 233 on Subscriber Service Card

Vacuum Materials Processor

An inert-gas flow meter is available from Elematic Equipment Corp. in flow ranges from 15 LPM to 2000 CFH with input pressures from 20 psig to 150 psig. The actuating mechanism



is a metering vane principle and is not affected by normal temperature changes. The unit is also unaffected by back pressures, and can be used in any position.

Circle No. 234 on Subscriber Service Card

High-Flow Pneumatic Regulator

A 2-in port-size pneumatic regulator with an inlet pressure of 6000 psi and outlet pressures from 100 to 6000 psi has been developed by the Benbow Mfg. The regulator is dome-loaded, for safety and simplification of design.

Flow is rated at 87,000 SCFM, AIR, at an inlet pressure of 6000 psi and an outlet pressure of 3000 psi. The regulator is suitable for use with air, nitrogen, helium and hydrogen. Also available is ½-in., ¾-in., 1-in. and 1½-in. port sizes. Port styles optional.

Circle No. 235 on Subscriber Service Card

The great paradox of our time, perhaps of all time, is that peace depends on our capacity to fight a war. Thus the person who contributes to our military strength, contributes to the cause of world peace.

MITRE's contribution is the design of command and control systems to give our military commanders the means to detect attack and retaliate.

The men who design these systems must think in terms of war and military operations — weapons, logistics, communications, intelligence, ability to destroy and ability to survive. They must be able to predict and solve the problems of future military command within the reality of existing or predictable electronic capability.

We call this "Military Command Technology."

MITRE's specific assignment is the design, development, evaluation, and integration of several interrelated, constantly evolving systems. It encompasses Command Systems (such as NORAD); Control Systems (such as SAGE); Intelligence Systems (such as MIDAS); and Warning Systems (such as BMEWS).

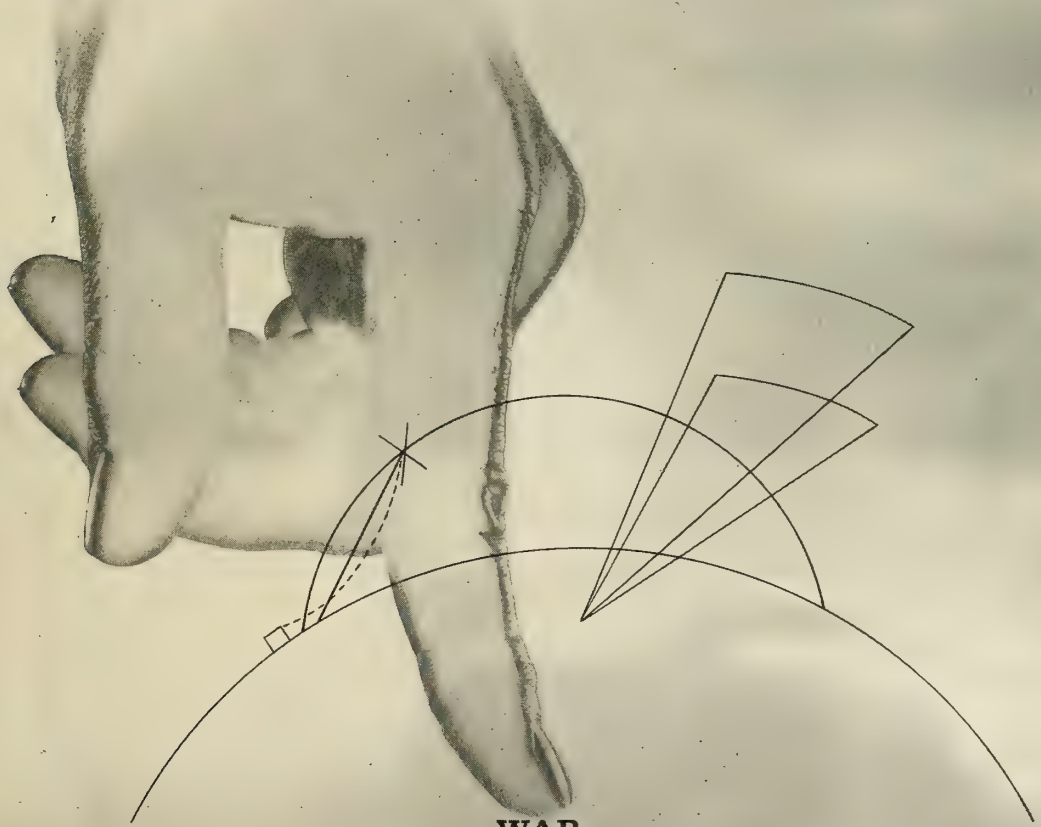
The work involves important new areas of technology in such fields as communications, intelligence, space surveillance, survivability, computer applications, data processing and other electronic techniques.

MITRE is located in pleasant, suburban Boston. Requirements: B.S., M.S., or Ph.D. in these disciplines — electronics, physics, and mathematics. Rewards are competitive. Openings also available in Washington, D.C. and Colorado Springs, Colo.

Write in confidence to Vice President—Technical Operations, The MITRE Corporation, Box 208, Dept. 9000, Bedford, Mass.

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WAR

How would it be fought?

What would this nation's strategy be?

What kind of decisions would have to be made?

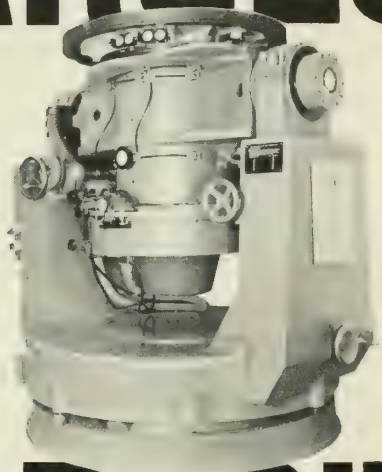
How would the commander command?

Who and what would survive?

MITRE is an independent, nonprofit corporation working with — not in competition with — industry. Formed under the sponsorship of the Massachusetts Institute of Technology, MITRE serves as Technical Advisor to the Air Force Electronic Systems Division, and is chartered to work for such other Government agencies as FAA.

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5800 lbs. Maximum Pure Thrust Load*
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66,000 in. lbs. Maximum Pure Moment Load**
0.5 in. lbs./Rad./Sec. Bearing Viscous Friction

*Send for charts indicating allowable load combinations ** About Moment Center 17" Below Table Face

New Dunn T918 Turntable has largest capacity and proven optimum performance for inertial platform and gyro testing. Options include servoed slip rings, frictionless torquers, and a variety of rate and angle readout systems. New T918 is now in use testing the NASA Saturn Guidance System. Write or call for more details on Dunn Air Bearing Turntables . . . an advanced concept for more accurate testing of large inertial systems.

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Circle No. 27 on Subscriber Service Card

new literature

MICROWAVE CATALOG — Because of the unique requirements of the microwave engineer, Hewlett-Packard has for the first time developed a special 32-page catalog dealing only with the generation, transmission, and measurement of microwave phenomena. For convenience in use, the contents of this catalog have been arranged by frequency range, rather than by model number. The publication is designed to be educational as well as convenient to use; the first few pages briefly review the basic microwave measurements, and photographs of typical equipment set-ups for these measurements appear throughout the catalog.

Circle No. 200 on Subscriber Service Card

MINIATURIZED POWER PACKS—Electronic Research Associates, Inc. has available a catalog describing a line of miniaturized solid-state high-current power packs. Supplying battery voltage outputs with a full choice of current ratings in their 200 ma. series, 500 ma. series, 1-, 2-, 4-, and 8-ampere series of units, they are intended to replace battery or laboratory sources of power. Full technical data, specification information, and size data are included.

Circle No. 201 on Subscriber Service Card

MINIATURE CONNECTORS—CEC design features incorporated in the 500C and 500D series miniature rectangular connectors are described in a 10-page bulletin from the Data Recorders Div. of Consolidated Electrodynamics Corp. The snap-in contact connectors reduce assembly costs to a minimum and are adaptable to automatic crimping methods. Pins and sockets can be intermixed in the same connector body.

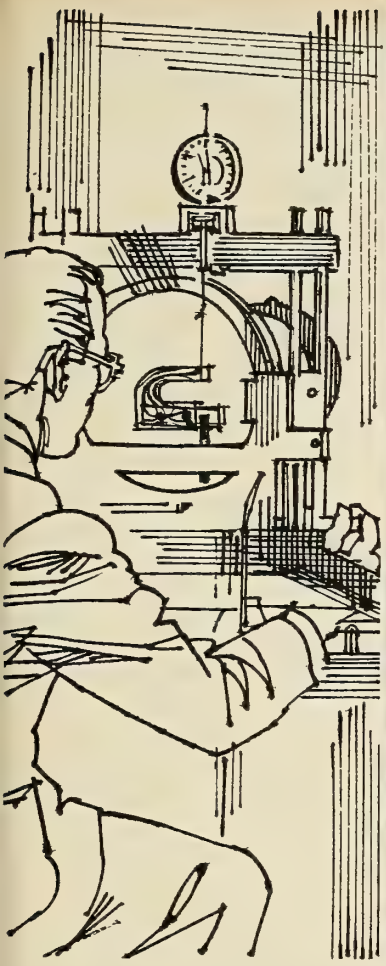
Circle No. 202 on Subscriber Service Card

THERMAL SWITCH — Eight models of liquid-in-glass thermal switches are described in bulletin T-12, issued by Precision Thermometer and Instrument Co. The eight-page bulletin gives application, output current ratings, thermostate ratings and prices.

Circle No. 203 on Subscriber Service Card

FLAME RETARDANT—Fireban 330, a cold-punch, flame-retardant paper-base laminated plastic, and Fireban 330E and 330R, copper-clad version of the material, are described in a bulletin published by Taylor Fibre Co. According to the bulletins, the flame-retardance and cold-punching properties of the new laminate are combined with high insulation resistance and good dimensional stability.

Circle No. 204 on Subscriber Service Card







Saturn openings at Boeing for Engineers and Scientists

Boeing has been awarded primary developmental, building and test responsibility for the Saturn S-IC advanced first stage booster. The Aero-Space Division's newly-formed Saturn Booster Branch has a number of immediate, long-range openings offering professional challenge, rapid advancement and ground-floor opportunities to graduate engineers and scientists.

This new Saturn program is expanding rapidly, providing unique advancement advantages to properly qualified Structural Design, Electronics/Electrical, Propulsion, Aeronautical, Cryogenics, Systems Test, Thermodynamics, Mechanical Design, Industrial and Manufacturing Engineers, as well as to Physicists and Mathematicians. Assignments are immediately available in many areas of activity, including Research and Development, Design, Manufacturing and Test. Salaries are commensurate with all levels of education and experience. Minimum requirements are a B.S. degree in any applicable scientific discipline. Boeing pays liberal travel and moving allowances to newly-hired engineers.



City Park—New Orleans

Assignments are in New Orleans as well as in Huntsville, Alabama. Positions with Saturn and with other expanding missile and space programs at Boeing — including the solid-fuel Minuteman ICBM and Dyna-Soar boost-glide vehicle — are also available at Seattle, Cape Canaveral and Vandenberg AFB, California.

Send your resume, today, to Mr. R. R. Gregg, The Boeing Company, P. O. Box 1680-MRU, Huntsville, Alabama. Boeing is an equal opportunity employer.

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contracts

AIR FORCE

$26,992,262—**Martin Marietta Corp.**, Baltimore, for work in connection with the *Titan I* and *Titan II* missile programs.

$13,924,416—**American Machine & Foundry Co.**, Greenwich, Conn., for work on *Titan I* launcher systems at various western Air Force bases.

$10,309,000—**General Motors Corp.**, Detroit, for work on a stellar inertial guidance system (supplemental contract). Work to be done at Milwaukee.

$6,986,060—**General Motors Corp.**, Detroit, for production of guidance equipment for *Titan II* missiles (supplemental contract).

$6,500,000—**Federal Electric Corp.**, Paramus, N.J., for work on a classified communications project.

$6,380,126—**American Machine & Foundry Co.**, Greenwich, Conn., for work on *Titan I* launcher system at Lowry AFB, Denver (supplemental contract).

$4,500,000—**Lockheed Aircraft Corp.**, Burbank, for production of *Agena* space vehicles (supplemental contract).

$4,035,653—**Aerospace Corp.**, El Segundo, Calif., for systems engineering, technical direction, management services and administrative support of ballistic missile and space programs.

$3,777,000—**Thiokol Chemical Corp.**, for production of *Stage I Minuteman* missile motors (2 contracts). Work to be done at Brigham City, Utah.

$2,859,400—**North American Aviation, Inc.**, Los Angeles, for provision of spare parts for the *Minuteman* guidance and control system. Work to be done at Downey, Calif.

$2,726,469—**Aerojet-General Corp.**, Sacramento, for research and development for *Titan II* propulsion system (supplemental contract).

$2,600,000—**Lockheed Aircraft Corp., Missile and Space Systems Div.**, Sunnyvale, Calif., for space satellite vehicles.

$2,430,219—**Martin Marietta Corp.**, Baltimore, for work on *Titan* ICBM's at Baltimore, Denver and Cape Canaveral.

$1,907,350—**Radio Corp. of America, Inc., Princeton Laboratories**, for a research program for the *Polaris* communication system.

$1,721,230—**Hughes Aircraft Co., Microwave Div.**, Los Angeles, for classified electronics equipment.

$1,650,000—**Aeronca Manufacturing Co.**, Middletown, Ohio, for design, development and production effort in the antenna, missile and satellite areas (5 contracts).

$1,526,610—**American Machine & Foundry Co.**, Greenwich, Conn., for work on *Titan I* launcher system at Vandenberg AFB, Lompoc, Calif.

$1,500,000—**General Precision, Inc.**, Little Falls, N.J., for work on a stellar inertial guidance system for space exploration.

$1,442,775—**General Dynamics Corp.**, San Diego,, for provision of installed property and related equipment for installation and checkout of *Atlas* missiles (supplemental contract).

$1,419,000—**Arvol D. Hayes Co.**, Lubbock, Tex., for construction of *Minuteman* support facilities at Minot AFB, N.D.

$1,240,966—**General Dynamics Corp.**, Los Angeles, for airborne and ground support equipment spares for *Atlas* missiles (supplemental contract).

$1,200,000—**Douglas Aircraft Co.**, Santa Monica, for research and development work on the *Skybolt* missile program.

$1,151,000—**Aerojet-General Corp.**, Sacramento, for *Titan* missile components.

$1,074,000—**Avco Corp.**, for research and development work on nose cones at Wilmington, Mass.

$800,000—**Aeronca Manufacturing Corp.**, Middletown, Ohio, for design and production of transportable communication antennas and the fabrication of component parts for a communications relay satellite.

$500,000—**Aeronca Manufacturing Corp., Aerocal Div.**, Torrance, Calif., for radar equipment and dorsal fins for two major missile systems.

$350,000—**Radio Corp. of America, Inc., Data Systems Div.**, Van Nuys, Calif., for production of components used in *Minuteman* missile aerospace ground equipment.

ARMY

$6,491,960—**Western Electric Co.**, New York, for further development work on the *Nike-Zeus* antimissile missile system.

$2,772,316—**Western Electric Co.**, New York, for additional development effort for the *Nike-Zeus* antimissile missile system (supplemental contract).

$2,000,000—**Martin Co.**, Orlando, for production of repair parts for the *Pershing* ballistic missile.

$1,365,783—**Northrop Corp., Ventura Div.**, Van Nuys, Calif., for production of 150 *SD-1* surveillance drones.

$1,256,000—**Western Electric Co.**, New York, for production of maintenance and repair parts for the *Nike-Hercules* air defense guided missile. Work to be done at Burlington, N.C., and the Douglas plant in Charlotte, N.C.

NAVY

$22,500,000—**Hughes Aircraft Co.**, Culver City, Calif., for manufacture of fire control systems for the *Polaris* missile.

$13,999,081—**Hughes Aircraft Co.**, Culver City, Calif., for fire control systems for *Polaris* missiles.

$7,022,497—**Lockheed Missiles and Space Co.**, Sunnyvale, for *Polaris* test equipment.

$6,880,000—**Northern Ordnance, Inc.**, Minneapolis, for *Terrier* missile launching systems.

$2,162,209—**Westinghouse Electric Corp.**, Baltimore, for production of *Polaris* equipment.

$2,029,434—**Sperry Piedmont Co.**, Charlottesville, Va., for gyroscopic stabilizers for fleet ballistic missile submarines.

$1,424,500—**American Optical Co.**, Keene, N.H., for target-detecting devices for *Sidewinder* missiles.

$102,844—**Vitro Corp.**, Silver Spring, Md., for shipboard engineering services in connection with testing of weapon systems on cruisers armed with *Talos* guided missiles.

NASA

$410,000—**Rocket Power, Inc.**, Falcon Field, Meza, Ariz., for a rocket catapult escape system for the two-man *Gemini* spacecraft.

INDUSTRY

$429,599—**Eclipse-Pioneer Div., Bendix Corp.**, Teterboro, N.J., from **North American Aviation, Inc.**, for production of angular accelerometers used in *Minuteman's* inertial guidance system.

$250,000—**Goodyear Aircraft Corp.**, Akron, from **Avco Corp.'s Research and Advanced Development Div.**, Wilmington, Mass,. for electronic research and experimentation on re-entry vehicle programs of the Air Force Ballistic Systems Div.

$250,000—**Avco Corp.'s Lycoming Div.**, Stratford, Conn., from **Thiokol Chemical Corp.**, for production of rocket motor cases.

$250,000—**United Technology Corp.**, Sunnyvale, Calif., from **Martin Co.**, Denver, for design, development and qualification of a solid-propellant retro rocket motor.

Minneapolis-Honeywell Regulator Co., Aeronautical Div., St. Petersburg, Fla., from **McDonnell Aircraft Corp.**, for development and production of guidance and control systems for the two-man *Gemini* spacecraft. Amount undisclosed.

The Marquardt Corp., Van Nuys, Calif., from **Aerojet-General**, for the first-stage nozzles for the *Polaris A3X*. Amount undisclosed.



Vandenberg Village, in one of California's fastest growing areas, presents an ideal environment for research, development and light manufacturing industries. The ultra-spacious, park-like industrial sites are centrally located in Santa Barbara County, a quick 4 minutes from Vandenberg Air Force Base, new headquarters of Strategic Air Command's 1st Missile Division. It is also within a mile of excellent residential and shopping areas. All utilities, including a proven water supply, abundant power, and city sewers, are available. Its proximity to the vast Southern California labor pool, service by major carriers, lower taxes, plus superb year around climate, are a few of the important advantages worthy of your consideration. Under the master development plan, you may purchase a site and build through private contractors or through the Vandenberg Village Development Company.

FOR COMPLETE INFORMATION PLEASE WRITE OR WIRE:
Mr. T. Mackie, Vandenberg Village Development Co.
3734 Constellation Road, Lompoc, California
UTAH CONSTRUCTION & MINING COMPANY

Circle No. 28 on Subscriber Service Card

soviet affairs

by Dr. Albert Parry

Cosmonaut Three is being increasingly mentioned in the Soviet press, but neither his name nor his photo is made public. On May 12 in *Krasnaya Zvezda,* the chief daily organ of the USSR's armed forces, an article by Major N. Kharitonov reveals some of the training being undergone by the man who will follow in Gagarin's and Titov's orbital footsteps. His movements are described as light and quick; his voice is praised as "confident and calm"; his work, with a few exceptions, is lauded as of the highest quality. His very few lapses are more or less excused as being of "incidental nature." (But we are not told just what these lapses are.)

Who are those colleagues of Yuri Gagarin and Gherman Titov—all those cosmonauts-in-training now designated by numbers only, also all the scientists, engineers, technicians, mechanics, and other skilled personnel making the cosmonauts' flights possible? "We don't know, we can only guess," declares Anatoly Agranovsky in a special article on this subject of Soviet rocketmen's anonymity, published in *Izvestia* last April 12. "They live among us. Most probably they are very much like ourselves. They also love their children; they read the same books we do; they sing the same songs. They sit next to us at the movies; we bump into them on the street and in the trolleybuses. These people have done everything for immortality. Only we do not know their names yet, and their faces are unknown to us. But we love them just the same—these nameless yet great contemporaries of ours, these men who have invented, calculated, built these most wonderful spaceships, who have sent them into cosmos."

Last year Gagarin said that the age of this anonymous personnel ranges from 25 to 55. This is one of the very few facts ever given out in the Soviet Union about these mysterious people. The secrecy is decreed by the Kremlin; it is strictly enforced. If you are even a small cog in the vast Soviet network of rocketry and missilery you are forbidden to tell this very fact to anyone, much less to reveal anything about your job. Manpower in the Soviet space program continues to be one of the Kremlin's top secrets. A year ago, on June 17, 1961, a list of honors to the builders and the guiders of Gagarin's *Vostok I* was published by Khrushchev. No names or photos were released. Only a handful of exceptions appeared, in the group photo; these men were a few Academy of Sciences officials beaming by Khrushchev's side. It was not clear whether these academicians had indeed contributed to the success of Red rocketry. They may have been summoned to the award-marking ceremony as symbolic representatives of the real contributors.

More than 7000 medals were on that occasion distributed to Soviet rocket scientists, engineers, technicians, and workers. In addition, collective honors were awarded (to quote an official announcement) to "a number of research institutes, design offices, and plants" in the rocket and missile industry. Visiting Moscow at the time, John Scott, an American journalist, heard from a Soviet friend that altogether, counting the staffs of the decorated organizations, "about 10,000 individuals got personal decorations." To this Scott remarked: "I'm guessing that if 10,000 got high decorations, twenty times that number did not. This would mean that nearly a quarter of a million people have been working on your space program. And these people, many of them, have to be highly qualified."

More than 250,000 Russians are in the space program, Scott's Soviet friend commented. "I think your numerical guess is on the low side," he said, "though I don't know." But he agreed that they were highly qualified. "Our best people," he said. "For many years now the rocket research projects have gotten the very best of personnel and resources, and all sorts of extras—bonuses, new houses, trips abroad . . . everything."

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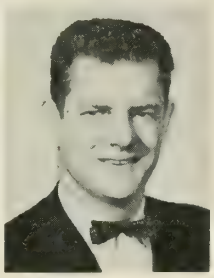


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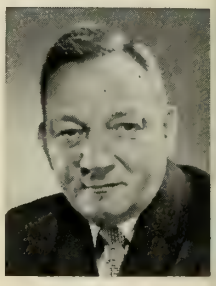
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MANGLE

R. C. Wells: Named director of administration for Martin Co.'s Support Division at Middle River, Md.

James V. Bernardo: Director of Educational Programs Division of NASA, selected as the 1961 recipient of the Frank G. Brewer Trophy.

Dr. Winston E. Kock: Appointed vice president of research for the Bendix Corp., Detroit.

Dr. Maria Telkes: Joined Cryo-Therm, Inc., Fogelsville, Pa., as director of research and development.

Brig. Gen. Charles S. Hays (USA ret.): Elected vice president of Maxon Electronics Corp., New York.

George A. Beck: Manager-industrial design for General Electric's Light Military Electronics Dept., awarded the 1961 Alcoa Industrial Design Award.

Edward I. Osborne: Appointed manager, product planning research, for the Thomas & Betts Co., Elizabeth, N. J.

Bernard De Angelo: Appointed vice president-marketing of General Instrument Corp.'s semiconductor division.

Edwin Wheeler: Appointed director of international operations of Datex Corp., Monrovia, Calif.

John E. Scherer: Appointed manager of the advanced systems section, sales development, of Hercules Powder Co.'s chemical propulsion division, Wilmington, Del.

Bert W. Holloway: Lockheed's corporate director of advertising, publicity and sales promotion, elected to the board of directors of Astro-Science Corp., Culver City, Calif.

George V. Butler: Named director of the newly created advance programs department of Douglas Aircraft Co.'s Missile and Space Div., Santa Monica, Calif.

Neil A. Armstrong: *X-15* pilot for NASA's Flight Research Center, Edwards AFB, Calif., named 1962 Octave Chanute Award Winner by the Institute of the Aerospace Sciences.

William E. Braham: Appointed director of plans and programs, H. I. Thompson Fiber Glass Co., Gardena, Calif.

John H. Mangle: Appointed executive vice president of Cook Electric Co., Chicago.

Paul R. Fitez: Promoted to the new position of corporate director of labor relations of Fairchild Stratos Corp., Hagerstown, Md. **Robert O'Brien** promoted to director of industrial relations of the Aircraft-Missiles Div.

J. Y. McClure: Director of reliability and quality control of General Dynamics Corp., San Diego, named chairman of the board and chief presiding officer of the American Society for Quality Control.

Charles H. Singer: Elected vice president of the U. S. Underseas Cable Corp., Washington, D. C.

J. Burton Henry: Elected vice president of International Resistance Co., Philadelphia.

Farar B. C. Martin: Named director of Federal Electric Corp.'s Early Warning Systems Div., Paramus, N. J.

Max E. Norman: Appointed manager of the St. Louis operations of Unidynamics.

Donald A. Hurter: Elected a vice president of Standard-Thompson Corp., Waltham, Mass.

Col. James C. Owen (USAF, Ret.): Named executive vice president in charge of administration of the Maytag Support Development Corp., Colorado Springs, Colo.

Dr. Helmut Schlitt: Promoted to director of engineering for the Avionics Div. of Textron's Bell Aerosystems Co., Buffalo, N. Y.

H. Malcolm Ogle: Appointed assistant to the president of Applied Systems, Palo Alto, Calif.

Alex J. Keller: Appointed manager of the newly organized Defense Products Dept., Garlock, Inc., Palmyra, N. Y.

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Dr. George J. Mueller: Appointed chief of applied research section of Cannon Electric Co.'s Research and Development Dept., Los Angeles.

Dr. Herbert E. Morris and **David L. Scott:** Elected vice presidents of Monsanto Research Corp., St. Louis.

Albert J. Kullas: Deputy director of engineering for the Martin Co.'s Denver division, received the 1962 Robert H. Goddard Award from Worcester Polytechnic Institute.

S. Dean Wanlass: Elected a vice president of Philco Corp., and appointed general manager of the Computer Div., Philadelphia.

Bernard J. Gallagher: Elected chairman of the board of Washington Technological Associates, Inc., Rockville, Md.

W. V. McGalliard: Appointed manager of the new American Bosch Arma Corp., office in Waltham, Mass.

Edward P. MacDonough: Named chief engineer for Chance Vought Aeronautics & Missiles Div., of Ling-Temco-Vought, Inc., Dallas, Tex.

Dr. Gerhard W. Braun: Named chief scientist at the Pacific Missile Range, Point Mugu, Calif.

Donald M. May: Project manager of TEAM, Hughes Aircraft Co., ground system group, elected president of the California Rocket Association.

Daniel Darnell, Jr.: Joined Northrop Corp., Hawthorne, Calif., as manager of Norair Div. Customer Relations Dept.

Robert D. Rosenthal: Named manager of corporate-level Spacecraft Systems Engineering Group, Fairchild Stratos, Hagerstown, Md.

John Scheck: Named marketing manager for electronic instruments at Allen B. Du Mont Laboratories, Clifton, N. J.

Joseph J. Martus: Joined Essex Electronics Div., Nytronics, Inc., Berkeley Heights, N. J., as engineering manager.



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Symposium on Electromagnetic Theory & Antennas, sponsored by the Technical University of Denmark, Copenhagen, June 25-30.

Progress Report to the Military Electronics Industry Professional Group on Military Electronics, IRE, Shoreham Hotel Washington, D. C., June 25-27.

Summer Institute in Dynamical Astronomy, Yale University, New Haven Conn., June 25-Aug. 2.

ASME Aviation and Space Division Annual Conference, University of Maryland, College Park, June 26-28.

Third International Symposium on Rarified Gas Dynamics, sponsored by AFOSR, Directorate of Engineering Sciences, ONR, NASA, University of Paris, June 26-29.

Ninth Annual Symposium on Computers and Data Processing by the University of Denver's Denver Research Institute, Elkhorn Lodge, Estes Park, Colo., June 27-28.

Fourth National Symposium on Radio Frequency Interference, IRE, Town House, San Francisco, June 28-29.

JULY

Reliability Training Conference, sponsored by Institute of Radio Engineers and American Society for Quality Control, Princeton Inn, Princeton, N. J., July 9-13.

Twelfth General Assembly, NATO Advisory Group for Aeronautical Research and Development, Paris, France, July 12-13.

Technical Report Writing for Engineers and Scientists, UCLA, Los Angeles, July 16-20.

American Rocket Society, Lunar Mission Meeting, Pick-Carter and Statler Hilton Hotels, Cleveland, July 17-19.

AUGUST

Society of Photographic Instrumentation Engineers, Seventh Annual Symposium, Statler Hilton Hotel, New York City, Aug. 6-10.

Institute of the Aerospace Sciences, Man Machine Competition, Olympic Hotel Seattle, Aug. 10-11.

American Institute of Electrical Engineers Pacific Energy Conversion Conference, Fairmont Hotel, San Francisco, Aug. 13-16.

International Seminar for Science Writers, Seattle, Aug. 13-16.

Nuclear Propulsion Conference, sponsored by ARC, ANS and IAS, U. S. Navy Post Graduate School, Monterey, Calif., Aug. 15-17.

American Society for Quality Control Joint Western Regional Aircraft and Missiles Conference, Benjamin Franklin Hotel, Seattle, Aug. 16-18.

Western Electronic Show and Convention, Los Angeles Memorial Sports Arena, Los Angeles, Aug. 21-24.

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A Member of the Wedding

LAST MARCH, when details of the proposed merger between the American Rocket Society and the Institute of the Aerospace Sciences first appeared in MISSILES AND ROCKETS, we heartily endorsed the marriage plans.

Our view has not changed. But a significant number of members in both organizations are opposed to the merger. They have been given very little opportunity to air their opinions. For that reason, we carry on p. 44 of this issue an interview with NASA's Kurt Stehling.

Mr. Stehling is a well-known and very active member of the American Rocket Society. He is among those who feel that the plans for the new American Institute of Aeronautics and Astronautics are ill-advised. He also feels the merger is being railroaded through by officials of the two organizations without ample opportunity for consideration and discussion.

On the latter point, we are inclined to agree. Broader opportunity should be provided for opponents of the merger to put their objections before the memberships for study.

IAS President L. Eugene Root told the IAS summer meeting in Los Angeles last week that the merger is "now or never." Many members, particularly in the younger and more virile ARS, feel it should be never. A rump ARS meeting in Washington recently discussed the plan—and then voted 12 to 6 against it in a straw poll. Several members who went to the meeting in favor of the merger changed their views after listening to the arguments.

Mr. Root pointed out that the considerable expense involved in preparing and voting on the proposition makes it impossible for either society to justify a repetition of the effort. This is true. It is equally true, however, that once they are married, divorce is impossible. Therefore, fullest consideration should be given to the pitfalls. We think a little additional money should be spent to circularize to the membership the views of those who oppose the merger. It also might be wise to finance a speaking tour to the chapters for one of the members, such as Mr. Stehling, who are most heartily against the plan.

We do not agree with the views of the group represented by Mr. Stehling. We think the merger will be most beneficial.

The suggestion by Mr. Stehling that the new organization will be so large that it will be impossible to manage is not a valid objection. Due to overlap in membership between the two societies, there will be some 30,000 members in the new AIAA. This is not an increase in size of such magnitude that it cannot be handled by efficient management. There are many similar groups which are much larger and which function effectively.

The Stehling interview points up the contrast of a vigorous, growing ARS with an IAS declining in membership. This is a nice way of expressing the hope of many ARS members that the IAS will quietly lie down and die so it can be decently interred. This, in their view, is a far more attractive prospect than merger. Unfortunately, it is a selfish view and such an event would do nothing to benefit the industry.

The IAS is a venerable and respected organization which provides its members with very worthwhile services. Its passing would be a great loss. If the merger were contemplated for no other reason than to bring to the IAS some of the youth and vitality of the ARS, it would be worthwhile.

There is little question that ARS is the more aggressive of the two organizations, that IAS has grown somewhat stodgy with age. But this, to us, seems to be a sound argument for the merger, not against.

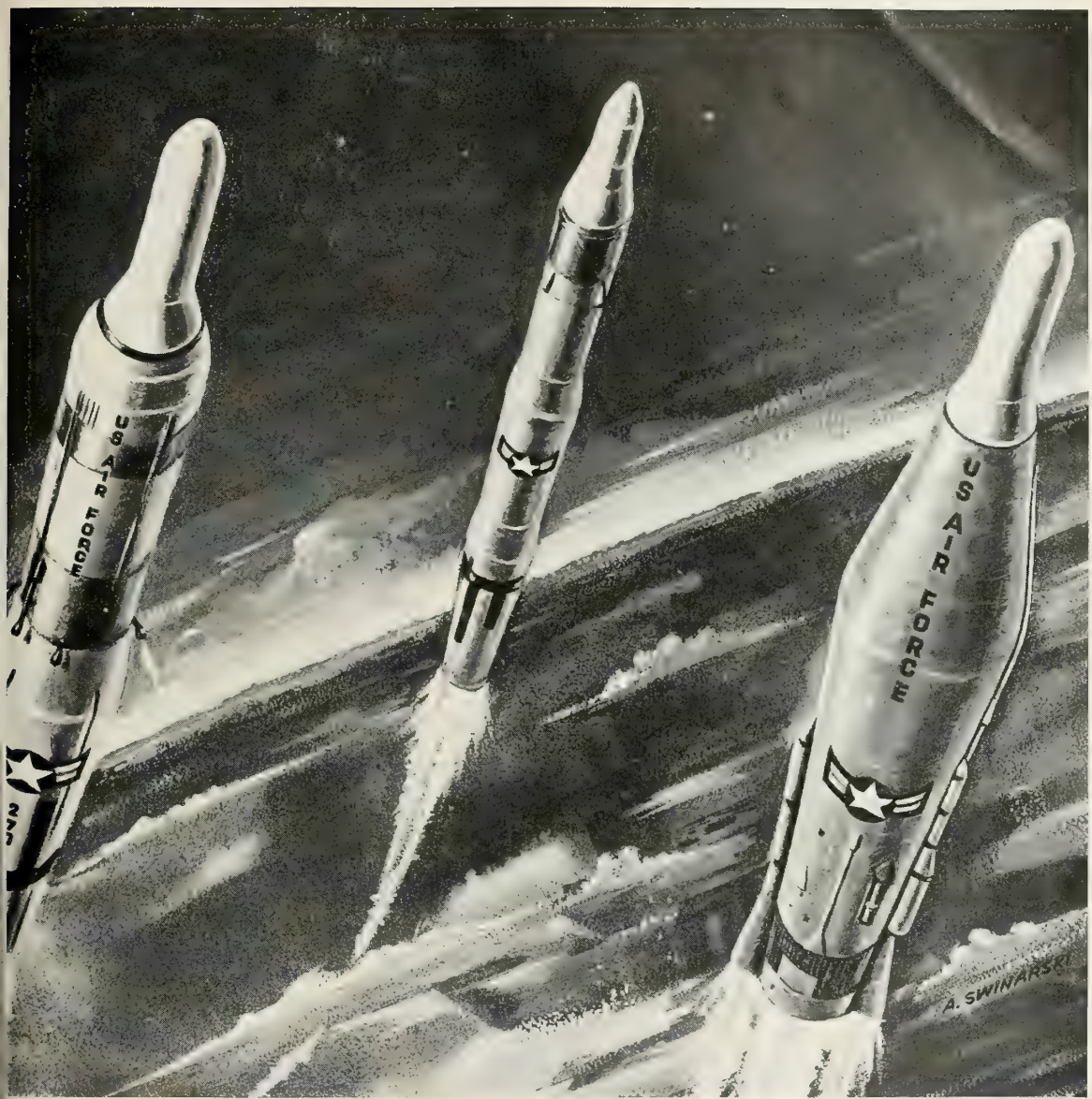
THE STEHLING OBJECTION to mixing aeronautical and astronautical disciplines in the same society is a valid one. We have commented on this previously. Our hope is that while divorce will be impossible after the merger, we can look forward to a future offspring in the shape of a re-born Institute of Aeronautical Sciences. We hope that the structure of the AIAA will recognize this as an eventual possibility and make provision for separation of two disciplines. The difficulties of their juxtaposition in an unsegmented organization can easily be seen from some of the IAS meeting programs.

But the proposal that the AIAA be splintered into eight or nine technical speciality groups with membership affiliation according to technical discipline seems to us a foolish one. We thought one of the objectives of such an organization was to provide an opportunity for specialists in the same field to get together and exchange technical information—so the electronics expert, for example, will learn something of what his colleagues in propulsion are doing.

Finally, Mr. Stehling's suggestion that societies should be competitive since they are really in a sense, in business seems to us quite misplaced. This is one area in which competition can be damaging, rather than beneficial. These are service organizations and definitely should not, in any sense, be in business. A look at the ARS financial statement suggests we are right.

But the views of Mr. Stehling and his fellow dissidents deserve a hearing. We hope you will start by reading the interview on p. 44.

William J. Coughlin



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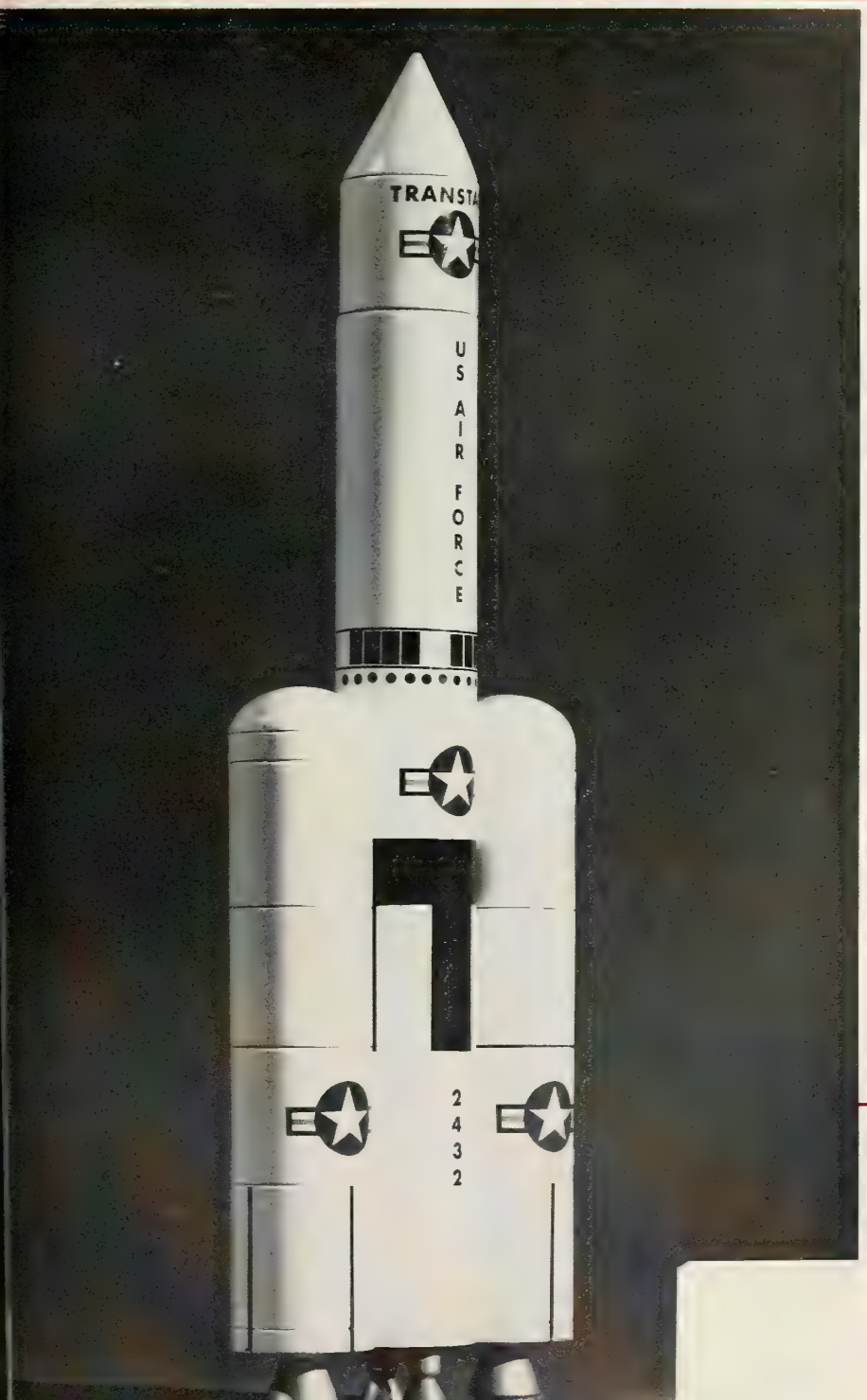
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JULY 2, 1962

missiles and rockets

THE WEEKLY OF SPACE SYSTEMS ENGINEERING

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JULY

Reliability Training Conference, sponsored by American Society for Quality Control, Princeton Inn, Princeton, N.J., July 8-15.

Institute in Technical and Industrial Communications, Colorado State University, Fort Collins, July 9-13.

Twelfth General Assembly, NATO Advisory Group for Aeronautical Research and Development, Paris, France, July 12-13.

Technical Report Writing for Engineers and Scientists, UCLA, Los Angeles, July 16-20.

American Rocket Society, Lunar Missions Meeting, Pick-Carter and Statler Hilton Hotels, Cleveland, July 17-19.

PERT (Program Evaluation and Review Technique) and CPM (Critical Path Method) Seminars, ITT Data Processing Center, Paramus, N.J., July 30-Aug. 1.

AUGUST

Engineering Foundation's Engineering Research Conference on Composite Materials, Tilton School, Tilton, N.H., Aug. 1-3.

Society of Photographic Instrumentation Engineers, Seventh Annual Symposium, Statler Hilton Hotel, New York City, Aug. 6-10.

Institute of the Aerospace Sciences, Man-Machine Competition, Olympic Hotel, Seattle, Aug. 10-11.

Pacific Energy Conversion Conference, American Institute of Electrical Engineers, Fairmont Hotel, San Francisco, Aug. 13-16.

Seventh Symposium on Ballistic Missile and Space Technology, U.S. Air Force Academy, Colorado Springs, sponsored by USAF and Aerospace Corp., Aug. 13-16.

Cryogenic Engineering Conference, UCLA, Los Angeles, Aug. 14-16.

International Seminar for Science Writers, Seattle, Aug. 13-16.

Nuclear Propulsion Conference, sponsored by ARC, ANS and IAS, U.S. Naval Post Graduate School, Monterey, Calif., Aug. 15-17.

Third International Electronic Circuit Packaging Symposium, University of Colorado, Boulder, Aug. 15-17.

American Society for Quality Control, Joint Western Regional Aircraft and Missiles Conference, Benjamin Franklin Hotel, Seattle, Aug. 16-18.

Western Electronics Show and Conference, Los Angeles Memorial Sports Arena, Los Angeles, Aug. 21-24.

International Symposium on Far Infrared Spectroscopy, Sheraton Gibson Hotel, Cincinnati, sponsored by Materials Central, Aeronautical Systems Div., Air Force Systems Command, Aug. 21-24.

Third International Congress, International Council of the Aeronautical Sciences, New Congress Hall, Stockholm, Sweden, Aug. 27-Sept. 1.

THE WEEKLY OF SPACE SYSTEMS ENGINEERING

missiles and rockets

Volume 11, Number 1 July 2, 1962

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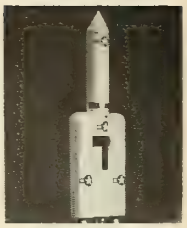
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THE COVER

First model photo shows configuration of Air Force's Martin Titan III space booster in full-scale form, with modified Titan II core, strapped-on UTC solid motors, and Aerojet-General's Transtage upper unit. *See p. 15.*



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†U.S. Reg. Pdg.

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Going to Bat for Casey

To the Editor:

Re your editorial, "Speak Up, Mr. Secretary" (M/R, June 18), you are now in line to be *Herald Tribuned!* Don't you know that you musn't criticize the Administration?

After all, the political appointees are getting plenty of experience by picking the brains of the professional military people . . . and then translating these professional recommendations into their own peculiar hodge-podge of theory without practice, in which they specialize.

Indeed, to style these people as "idealistic dreamers or such ignorant clods" or "babes in the woods" is *very* naughty.

I am all for the theory of "civilian control"—if it is properly applied. However, what is happening in DOD today is seriously analogous to a baseball fan (the political appointee) conducting an interview with Casey Stengel (the professional military man)—and then trying to run the baseball team.

What the professional military man (Casey Stengel) needs are the finances and front office management to obtain the players (systems) which he, as the professional expert, needs. Casey is the man who knows what he requires. If he needs a pitcher or a third baseman, it obviously is folly for management to get him a new water boy and a centerfielder simply because Casey says he needs "personnel."

You should hook up with Captain Taussig, who lost his retired pay for reminding DOD that they, as the men in authority, owed their subordinates a personal loyalty downwards, to a greater degree, even than they expected the loyalty of their subordinates to flow to the top.

We now have two strikes against us in the game: (1) Interference with military decisions under the guise of "civilian control" and (2) An obvious propensity to ignore (or fail to appreciate) a primary principle of leadership—responsibility to subordinates.

I wonder when the third strike will be pitched?

Frank Walker
Clinton, Md.

Weekly Constitutional?

To the Editor:

I take issue with the closing remark in your June 18 editorial, which expresses horror at the thought of DOD civilians running the Pentagon.

Sorrowfully I must inform you that this is the way the Constitution said it must be (civilian control of the military); this is the way most Americans want it; and I hope after due thought you may find it possible to reconcile yourself to that idea.

Is it possible that you and your staff spend so much time in the company of the military that you gradually take on the viewpoint of so many of them who, like MacArthur and Walker, think the country was made for them, not vice-versa? I prescribe regular weekly reading of the Constitution and the history of those countries which did *not* carefully see that civilian control of the military was paramount.

Rinehart S. Potts
Levittown, N.J.

Engineering Equivalency

To the Editor:

I have been reading your letters concerning engineering degrees and engineer shortages with considerable interest, since it is a subject very close to my heart.

With a total of about four years of technical schools, a few college credits and over 15 years of diversified electronics experience, I have had much trouble trying to convince industry that I am equal to any man with a degree. Completely fed up with industry, I recently went to work for the government as an Electronic Technician. I immediately applied to take the electronic engineering equivalency exam, and passed it on the first try. So technically, as far as Uncle Sam is concerned, I don't need a degree no more! I am now waiting for an engineering billet, which I don't believe will take very long.

In my opinion it is indeed a dirty form of discrimination to hire an engineer on the basis of where he obtained his degree or even whether he has one. After some study for the examination, I feel that the state engineer exams are not completely applicable for most types of engineers. The civil service examinations consist of 50% engineering fundamentals and 50% of the specialty (electrical, civil, mechanical, etc.), and are much better in these modern times than the state types.

Since industry will not voluntarily eliminate educational discrimination, I think that the government should pass laws requiring examinations of all engineers on defense work, including those with degrees. Once the exam is passed this fact only should be entered on any application concerning education. Discrimination in any form concerning education should then be absolutely forbidden, just as it is for race, color, or religion. The exams should be designed so that most persons with degrees could pass without excessive study—to make it fair for all concerned.

I am a strong believer in examinations. Nothing really proves how much a person knows as well as a good stiff exam.

William L. Timmons
NAG
Pt. Mugu, Calif.



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Asian Sympathizer

To the Editor:

Your May 14 editorial, "Go Home, Russian," made very interesting reading.

However, I wasn't as surprised as others, since your other editorials had in the past touched on similar points, i.e., if the American scientists want to know various results like medical, thermal, physiological effects after 18 orbits, it is better they discard Titov's test results and launch their own man to find the truth.

I had similar experiences when I attended a lecture on Titov's flight by Prof. Martenov of Moscow's Planetarium. He refused to divulge such elementary facts as how many doors the capsule had, what was Titov's reaction due to varying g-forces, and what environmental system the capsule possesses, etc.

In fact, he lost no time in making a mockery of Shepard's flight, according to his whims and fancies, and of course, many more not worth writing!

However, I defended Shepard's flight from the technical standpoint, but could not convince him. It looked like a propaganda meeting rather than a technical lecture.

One thing should be made clear—i.e., I am losing no time and shall lose no time in defending America's space prospects. Not because of any personal feelings, etc., but because your country's achievements cannot be compared with the Russians' achievements, since the systems of governmental application are entirely different.

America is a free country and has numerous problems, which you people are well aware of.

R. V. S. Mani
6/595 Mani Villa
Vincent Road
Matunga
Bombay 19, India

'Pilot Error' Skeptic

To the Editor:

"Bravo" to Captain Frank V. Martin's letter, "Dividing the Blame" (M/R, June 18, p. 6).

C. H. Foster
Jacksonville, Fla.

Astrolog Reprints

Reprints of the latest Astrolog (appearing on pp. 21-27 of this issue) may be ordered from:

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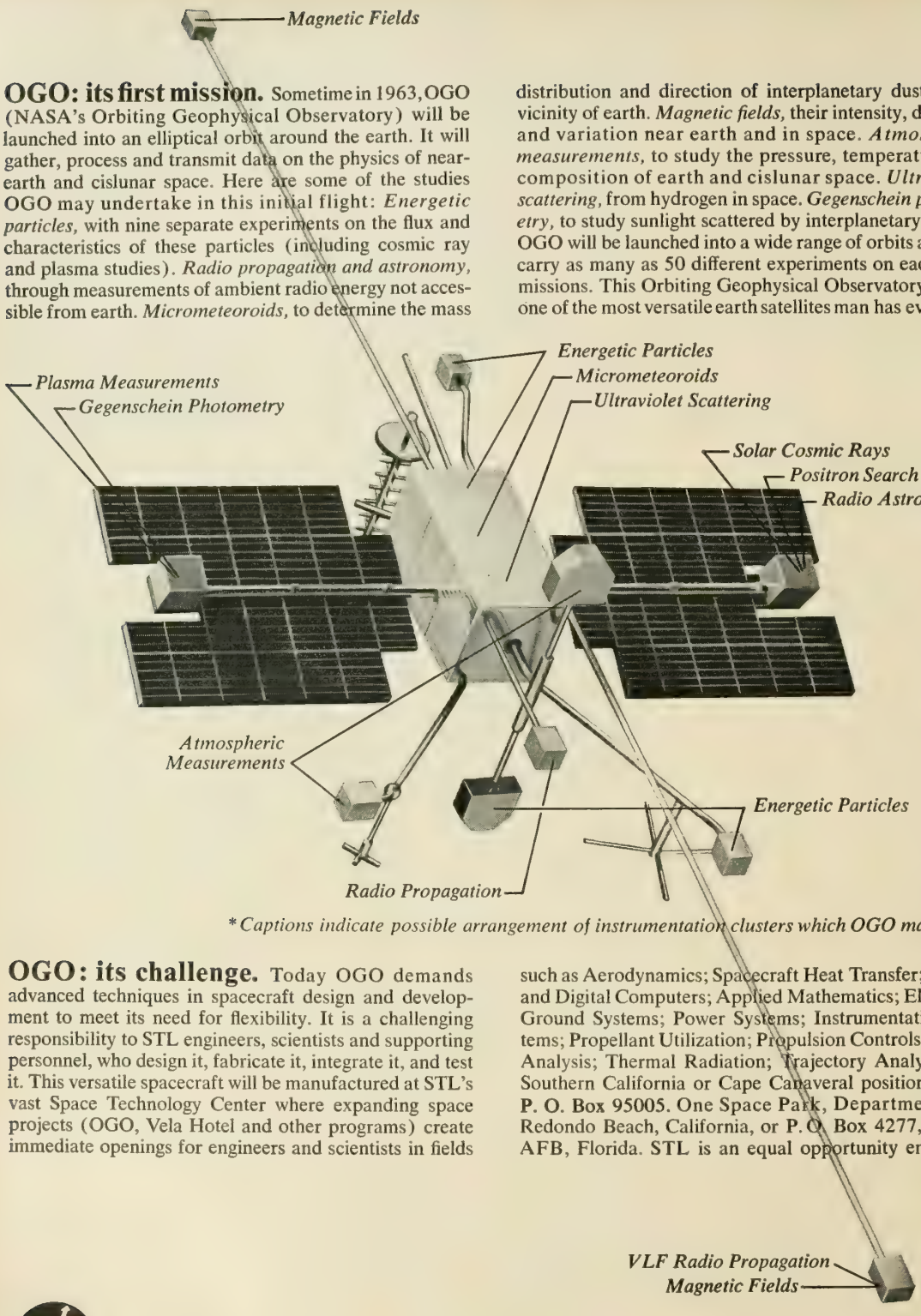
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Reliability Engineers to assess the reliability and to optimize the configurations and mission profiles of space systems.
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NORTHROP
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OGO: its first mission. Sometime in 1963, OGO (NASA's Orbiting Geophysical Observatory) will be launched into an elliptical orbit around the earth. It will gather, process and transmit data on the physics of near-earth and cislunar space. Here are some of the studies OGO may undertake in this initial flight: *Energetic particles,* with nine separate experiments on the flux and characteristics of these particles (including cosmic ray and plasma studies). *Radio propagation and astronomy,* through measurements of ambient radio energy not accessible from earth. *Micrometeoroids,* to determine the mass distribution and direction of interplanetary dust in the vicinity of earth. *Magnetic fields,* their intensity, direction and variation near earth and in space. *Atmospheric measurements,* to study the pressure, temperature and composition of earth and cislunar space. *Ultraviolet scattering,* from hydrogen in space. *Gegenschein photometry,* to study sunlight scattered by interplanetary matter. OGO will be launched into a wide range of orbits and may carry as many as 50 different experiments on each of its missions. This Orbiting Geophysical Observatory will be one of the most versatile earth satellites man has ever built.



**Captions indicate possible arrangement of instrumentation clusters which OGO may carry.*

OGO: its challenge. Today OGO demands advanced techniques in spacecraft design and development to meet its need for flexibility. It is a challenging responsibility to STL engineers, scientists and supporting personnel, who design it, fabricate it, integrate it, and test it. This versatile spacecraft will be manufactured at STL's vast Space Technology Center where expanding space projects (OGO, Vela Hotel and other programs) create immediate openings for engineers and scientists in fields such as Aerodynamics; Spacecraft Heat Transfer; Analog and Digital Computers; Applied Mathematics; Electronic Ground Systems; Power Systems; Instrumentation Systems; Propellant Utilization; Propulsion Controls; System Analysis; Thermal Radiation; Trajectory Analysis. For Southern California or Cape Canaveral positions, write P. O. Box 95005. One Space Park, Department B, Redondo Beach, California, or P. O. Box 4277, Patrick AFB, Florida. STL is an equal opportunity employer.

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The Countdown

WASHINGTON

Decision Nearing on Apollo

NASA Administrator James Webb is to be briefed this week on conclusions of the vital systems engineering review of the *Apollo* program. The management steering group still was polishing the report late last week. Announcement of a decision, expected to favor lunar-orbit rendezvous, thus appears to be at least one to two weeks away.

After Six Comes Eighteen

Project *Mercury's MA-8* shot, planned for six orbits, probably will be the last step in NASA's manned space flight program before it moves into 18-orbit missions early next year. No firm decision has been made, but only serious technical problems are expected to cause any repeat of the *MA-8* mission.

AF Still Studying Mobile ICBM

Cancellation of the mobile *Minuteman* program does not mean that any possibility of a mobile ICBM is dead, according to high Air Force officers. Other approaches are under study. AF also is still studying possible deployment of ICBM's on a world-wide basis.

More Bones for Pluto and Rover

Atomic Energy Commission will build seven reactors for NASA's *Rover* nuclear rocket program in Fiscal 1963. In addition, industry will build four. This compares with a total of five by both government and industry in Fiscal '62. AEC will spend $74.8 million during Fiscal '63 on *Rover* and $29 million on Project *Pluto*.

ComSat to be Pushed Through

Kennedy Administration officials are determined to push the commercial communications satellite bill into law during the current congressional session. Debate on the measure is temporarily suspended, but Senate Democratic leaders have assured the White House it will be resumed, with subsequent passage of the bill.

Nuclear Upper Stage Slipping

AEC officials are joining the long line of Administration spokesmen who are shying away from the 1966-67 deadline for the first flight of a nuclear upper stage. One AEC member told Congress recently it will be very difficult to meet that deadline.

INDUSTRY

s Lockheed Buying Short?

British reports say Lockheed Aircraft Corp. may be interested in purchase of Short Brothers and Harland Ltd. of Belfast, Northern Ireland. Lack of orders for aircraft is forcing the pl t to shut down. This means Short's production of th leacat guided missile also will cease. Largest shareholde in the company is the British government—also its lar t customer—with 69½% of the company's shares. Ren..ining shares are split between shipbuilders Harland & Wolff and Bristol Aeroplane Co., a subsidiary of British Aircraft Corp.

LRL Expanding in Fundamentals

Lawrence Radiation Laboratory of the University of California is expanding research in fundamental physics. Dr. Theodore Merkle will head a new physics department which will undertake work in neutronics, physics and theoretical physics.

INTERNATIONAL

Pakistan Fires Weather Probe

A newly-developed two-stage weather rocket was fired recently by Pakistan from the Sonmiani Beach range, some 35 miles west of Karachi. It carried an 80-lb. load of sodium to a height of about 80 miles, with the sodium trail being photographed.

Blue Streak Tests Completed

Static testing of Britain's *Blue Streak* was completed June 15 at Spadeadam after more than 400 tests since August, 1959. Flight testing at Woomera, Australia, will follow.

French Develop Missile Platform

France's Naval Arsenal at Cherbourg is developing an experimental platform for testing of the *MSBS* sub-launched missiles which will equip the six *Polaris*-type atomic submarines planned by France.

New Tracking Station for Britain

Britain's Norman Lockyer Observatory at the top of Salcombe Hill, Sidmouth, Devon, is being modernized and equipped with the latest electronic equipment to enable it to specialize in tracking man-made satellites. Since its founding in 1913, the observatory mainly has been concerned with stellar spectroscopy.

France May Give Up ICBM Program

French reports say the government has decided to abandon its ICBM plans in favor of concentration on air-launched and sub-launched ballistic missiles. Reason: problems of siting ICBM's on French territory.

Soviets Behind in Electronics

Recognition that Russia is lagging behind the U.S. in electronics is implied in a report prepared recently by Deputy Chairman M. Litachev of the Science-Technical Council of the State Committee for Electronics Engineering of the Council of Ministers of the USSR. He asserts that the future of Soviet work is bound up with the hopes of a breakthrough in microminiaturization.

MA-8 Aims for Six Orbits

NASA has announced that its next *Mercury* manned spaceflight will be planned for as many as six orbits.

D. Brainerd Holmes, director of the space agency's office of Manned Space Flight, said the flight will be made late this summer. Best best is sometime in September.

Astronaut Walter Schirra has been selected as the pilot, with astronaut L. Gordon Cooper as backup (M/R, June 4, p. 15).

Holmes said that NASA Administrator James E. Webb "has authorized us to proceed with as much as a six-orbit mission."

He emphasized that the decision as to the specific mission will depend on many technical factors which will be evaluated constantly up to the flight and during the initial orbits.

"We believe that another three-orbit mission will increase considerably our growing knowledge of space flight," Holmes said. "Anything more would be a bonus."

He said a full nine-hour six-orbit mission will require no major change in spacecraft equipment. The flight plan, however, will call for considerably more drifting to conserve fuel.

NASA said the landing point for a four-orbit mission will be 200 miles east of Midway Island in the Pacific Ocean. Landing site for a five- or six-orbit mission will be 500 miles northeast of Midway.

Dyna-Soar = X-20

The Air Force has dropped the name *Dyna-Soar* for its manned reentry glider and adopted the letter-number designation *X-20,* officially describing the craft as an experimental vehicle (M/R, March 12, p. 9).

The glider has always been in the experimental category—current policy authorizes only its development as a step toward manned space flight presumably of a military nature. There is as yet no firm program for the *X-20* as a military system, and no firm directive for its booster development — *Titan III* or Project *642A,* its Air Force appellation. The booster package is under DOD review and a decision is expected "soon."

'Empire' Study Contracts

Marshall Space Flight Center has awarded contracts to three firms—Ford Aeronutronic, General Dynamics/Astronautics and Lockheed Missiles & Space Co.—for six-month studies of early manned planetary exploration.

The study program is called *EMPIRE*—Early Manned Planetary-Interplanetary Roundtrip Experiment. It will cost a total of $250,000.

Lockheed and Ford will study Mars flyby missions, GD/Astronautics a Mars-orbiting mission. Marshall said the award of the contracts doesn't mean it has scheduled such flights, but rather that preliminary information is being developed. Studies assume launch time in the early 1970's and use of *Saturn C-5* and/or *Nova* launch vehicles employing orbital operations and nuclear propulsion from Earth orbit.

Shots of the Week

The highly successful North American *X-15* rocket plane streaked to two new records within a week.

On June 27, NASA pilot Joe Walker "accidentally" took the plane to a world speed record for winged aircraft of 4159 mph. The flight plan called for a top speed of 4000 mph.

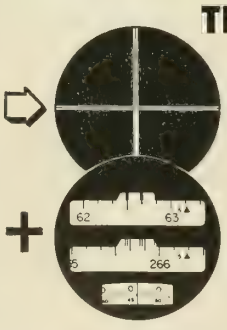
Air Force pilot Maj. Bob White, who held the old speed mark of 4093 mph, on June 21 set a new world altitude mark by taking the *X-15* to 250,000 ft.

• The second attempt to detonate a nuclear device in space ended in failure June 19 when the *Thor* launch vehicle was destroyed two minutes after launching from Johnston Island in the Pacific. A third attempt has not yet been scheduled in the Pacific series.

LA Security Meeting

Recommendations for "procedural" modifications to speed release of contractor press information will be made to Air Force Systems Command headquarters as a result of a Los Angeles meeting between top public relations representatives of several missile/space firms and information officers at Aerospace Systems headquarters.

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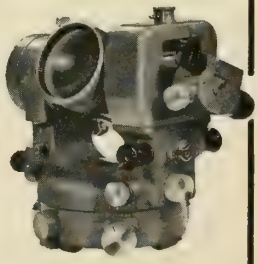


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AF spokesmen stressed that the recommendations are "strictly procedural, not policy-type" suggestions.

"In order to help speed information release, we are going to suggest that the information be sent direct to Systems Command headquarters with information copies to other agencies—instead of having to go step-by-step up the chain of command," one said.

AF spokesmen expressed concern that what they called "a strictly local-level informal meeting" had been interpreted as an effort to circumvent DOD policy.

Shillelagh Team Listed

The Army has approved a new list of contractors for its tank-fired *Shillelagh* guided missile.

Ford Motor's Aeronutronic Div., prime contractor for the system, will also be guidance and control contractor. Among the other firms on the team are Raytheon—receiver; Norris-Thermador—motor case; and Picatinny Arsenal/Amoco Chemical Corp.—propulsion.

Konecci To Head Life Support

NASA has appointed Dr. Eugene B. Konecci as Director of Biotechnology and Human Research in the Office of Advanced Research and Technology.

He will assume the newly-created position on July 9, 1962.

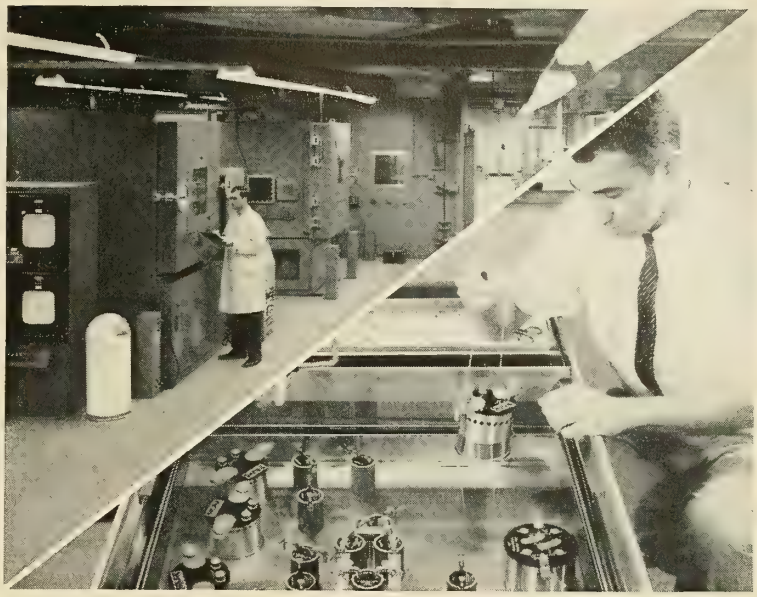
Flux Fuss Downgraded

Recent widely published Soviet criticism of U.S. scientists for not crediting Russia with a space discovery has been dismissed by a noted NASA scientist as a "tempest in a teapot."

The NASA expert, who asked to remain anonymous, explained that U.S. scientists freely admit that the Soviet was first to determine experimentally that the maximum electron flux in the Earth's outer radiation belt was of the order of 10^{-8} particles per square centimeter per second. He added, however, that the Soviet conclusion was based on an unconfirmed assumption.

He said a group of U.S. experimentalists had previously made a similar unconfirmed assumption on the basis of satellite data which resulted in an estimate of 10^{-11} particles (M/R, Jan. 29, p. 31). This group was "surprised," he said, when *Explorer XII* results—based on definitive measurements—confirmed the Russian conclusions.

services for aerospace contractors:



ENVIRONMENTAL EVALUATION

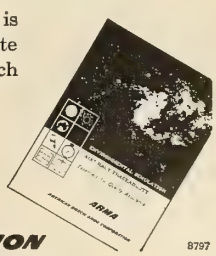
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A start in FY '64? . . .

New High-Energy Engine Planned

NASA official says advanced liquid powerplant will be vital; House group scores Centaur management

by Hal Taylor

A TOP NASA official reports that the space agency plans to begin development of a new high-energy liquid-propelled experimental engine in Fiscal 1964.

John L. Sloop, director of NASA's Office of Power Generation and Propulsion, told MISSILES AND ROCKETS the engine probably will use some combination of hydrogen and fluorine. Total cost is estimated at $20 to $30 million.

At the same time, the space agency's current high-energy propulsion program came under fire from a House Space subcommittee. The subcommittee, in a report on its recently completed investigation of the *Centaur* liquid hydrogen program, criticized all aspects of the project's management.

In other major recommendations, it called on the space agency to study the possibility of a top DX priority for the program and a proposed Government Accounting office (GAO) investigation of *Centaur* industrial contracts.

While Congress was criticizing the space agency's current high-energy propulsion program, NASA officials already were laying the groundwork for a follow-on project.

Sloop told M/R he expects the space agency to start development on the new experimental engine by Fiscal 1964 or 1965 at the latest. He estimated total development time at two to five years.

He said that the program still has not received budgetary approval. In fact, he said the high-energy research program is undergoing a cost study phase at the present time.

He added, however, that he expects a substantial raise in the program's budget in Fiscal '64.

• **Fuels pondered**—Sloop said the space agency has in the past studied, and is currently studying, several possible propellant combinations. He said that no final decision has been made, but the experimental engines which will be built will probably use fluorine.

Hydrogen appears to be the best choice for the engine's fuel.

Among the fuels which NASA has studied are boron hydrides, hydrazine blends and hydrogen. The oxidizers include oxygen, fluorine, and fluorine compounds.

• **For the future**—Sloop said that while there is no current requirement in NASA programs for the new high-energy propulsion engines, studies made of future space agency propulsion needs indicate they are necessary.

"As our missions become more difficult," he said, "higher-energy propulsion will be needed."

Among the possible uses for the new propulsion system, he cited landing and takeoffs from planets, attitude control power, and other places "where you want a compact lightweight propulsion system."

He said that if nuclear-powered rocket stages are successful in all respects, they probably will replace chemical rockets for use in large powerful upper stages for space boosters. He added, however, that they are too heavy to fill lightweight compact propulsion needs. Electrical propulsion also will not fill the bill, he continued, because it has a low thrust-to-weight ratio.

• **"Constructive criticism"**—The *Centaur* program started in about the same manner as new high-energy propulsion project. It started as an experimental engine to develop hydrogen technology.

This was one of the reasons cited by the House Space Subcommittee for some of the program's problems.

Subcommittee Chairman John H. Karth (D-Minn.) said that from this experimental start, it was rushed into the space program so quickly that management and funding planning was not always adequate.

Terming the report "constructive criticism," Karth said that it "properly criticizes everyone who had anything to do with the *Centaur* management." He added, however, that the report drew no conclusions as to actual mismanagement of the Air Force-NASA govern-

(Continued on page 40)

DOD Reported Ready to Seek Proposals on 260-Incher

A PENTAGON official reports that DOD will soon initiate requests for proposals on development of a flightweight 260-in. solid motor.

The official indicated that the announcement could come early in Fiscal 1963.

He said NASA Administrator James E. Webb and Secretary of Defense Robert S. McNamara have agreed on the vehicle's overall requirements. Some minor technical details still must be worked out, he added.

The prediction came in the face of reports from some quarters in NASA and the Air Force that the procurement might be delayed for as much as three to six months. These reports cited DOD-level review as the main reason for the possible new delay in the contract, which the Air Force had earlier told Congress would be awarded by June 30.

The Pentagon official also said that similar development of a 156-in. solid motor is not "dead," only delayed by NASA-DOD discussions as to whether it is really needed. But he indicated that a final decision on the smaller motor is a long way off.

An informed source reported that once the contract is awarded it probably will involve building about three of the giant solid motors at a cost of $15 million each—a total cost of $45 million.

SNAP-50 at core . . .

3-Way Nuclear Space Power Struggle Goes On

SHARP NASA-AEC-Air Force disagreement continues to split the U.S. nuclear space power development program.

Currently centered in the *SNAP 50* program, the discord could spread to all future space projects in the nuclear field.

The interagency dispute was revealed by Gen. A. R. Luedecke, AEC general manager.

He told the House Appropriations Committee there "is a lack of understanding between NASA and the AEC over the *SNAP 50* program." He added that the Air Force is also involved.

His statement confirms a MISSILES AND ROCKETS exclusive report (Feb. 19, p. 12). The closed-door committee hearings were held on May 29.

On June 26, officials of NASA's nuclear propulsion office reported that "no accord has yet been reached."

Thus, the program has been delayed for at least four months.

More important, unless the jurisdictional dispute is settled permanently it could continue to throttle future projects.

• **Sore points**—Administration officials report disagreement over three issues:

1. NASA does not want to build or fund the *SNAP 50,* which is a space power unit in the 300 kw to 1 megawatt range, as fast as the AEC wished.

2. Both agencies would like to develop and contract with industry for the conversion equipment which will change the nuclear energy to electrical power.

3. The agencies support differing types of management superstructure.

The Air Force—while not actively involved in the *SNAP 50* dispute—holds substantially the same position as NASA regarding management and control of its nuclear power systems. This is principally concerned with *SPUR*—the Air Force counterpart of *SNAP 50.*

Dr. Edward Welsh, executive secretary of the National Space Council, said that the dispute has not yet reached the council for action. "We hope and expect that it will be settled soon by the agencies themselves," he said.

Both NASA and AEC officials indicated that the solution may be off for some time.

Gen. Luedecke, in testifying before the committee, confirmed the essential points in dispute.

"Our lack of understanding with NASA at the moment," he said, "is on timing with respect to the undertaking of development of the other components of the system and the organization under which it should be done."

Specifically, he said, discussions have been held with the space agency on the timing for proceeding with the various elements of the program—"consisting primarily of a heat source for reactor conversion equipment to electrical energy and conversion of that to propulsion energy in terms of ion propulsion."

The AEC official said that several meetings have been held.

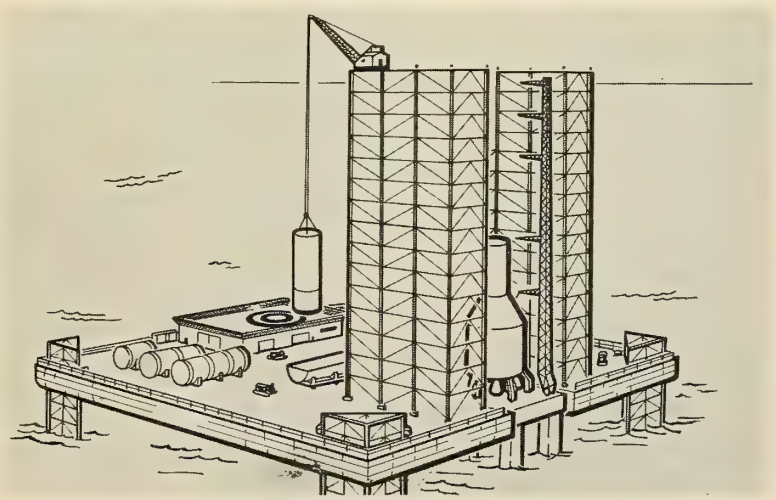
• **"Just where we started"**—Committee chairman Clarence Cannon (D-Mo.) declared that an agreement must be reached so that the committee will know where to appropriate funds.

Referring to the joint NASA-AEC agreement which laid down the outlines of each agency's responsibility in the *Rover* program, Cannon said "this understanding, the *Rover* issue having been eliminated, leaves us just where we started. The statement is made emphatically on at least one side that there is no understanding and apparently no attempt to reach an understanding. We would like to know when there can be a general agreement on which we will know where to put this money."

Later, AEC stated its position.

"The Commission conceives its role in the production of electrical power in space as one of design, development, and test of a complete power package, including the power source and energy conversion system," it told the committee. "This position is taken in view of the requirement for extreme reliability of each component and interdependence of these components in the power system. The power source and energy conversion loop are closely integrated and thermodynamically coupled through a common heat exchanger. This system must be tested as a combined unit in a nuclear facility which involves all the attendant safety consideration.

"Also, there is the consideration that both NASA and the DOD have potential electrical power requirements for several applications and, further, it may be necessary to provide electrical power requirements direct to the communications industry for their electronic payloads. It is, therefore, believed that maximum progress and efficiency can be achieved if the combined power and conversion unit is under the cognizance of a single agency." ⌗



For Canaveral's Overflow

ARTIST'S DRAWING of off-shore launch pad proposed by a Douglas Aircraft Co. Missile and Space Systems design engineer as a possible cure for the manned-space-flight-launching traffic jam eventually expected at Cape Canaveral. The structure would be located five to 10 miles off the coast in water 30 to 60 ft. deep.

SLAM flight by '66? . . .

Air Force Seen Okaying Pluto Tests

THE AIR FORCE apparently will give the Atomic Energy Commission a go-ahead for ground-testing its $600-million Project *Pluto* nuclear ramjet—designed to power the *SLAM* missile.

This means the supersonic low-altitude missile could be flight-tested in 1966.

The Navy has also asked the AEC to study possible configurations which could be launched from *Polaris* submarines.

These and other details of the program were disclosed by AEC officials in just-released testimony before closed-door hearings of the House Appropriations Committee.

The officials said the *Pluto* work was been one of its more successful reactor programs—so successful that the agency has decided to run tests on only one more reactor before the start of ground tests.

"There seems to be nothing limiting in the reactor to prevent it from doing those things we set out to do," Dr. Frank Pittman, director of reactor programs, declared.

AEC spokesmen admitted that DOD still has not established a requirement to go from the current research program into a flight-test weapons system. DOD has indicated, however, that if reactor tests continue to be successful it will authorize the ground-test phase.

• **More money**—As evidence of their interest, one official said DOD has authorized the Air Force a better than 300% increase in funding—a jump from $7 million in Fiscal '62 to $24 million in Fiscal '63 for the *Pluto* project.

He said the AEC estimates that its total cost throughout the flight-test phase will be $141 million, with $35 million to be spent from Fiscal '64 through Fiscal '66.

The Air Force, he said, has pegged its total costs in the program through flight-testing at about $500 million.

• **Gratification**—AEC officials indicated they were enthusiastic and happy over the results of the reactor test program.

The first Project *Pluto* reactor, IIA-1, has been tested five times, according to Irving Hoffman, director of the program for the agency.

"The first was in May, 1961, at partial power, and then in September and October at full power.

"On Oct. 5, we drove the reactor to full conditions. In essence, we flew the reactor statically. On Oct. 6, we again operated the reactor. This time we imposed a higher-than-design thermal stress upon the reactor to gain a feel for the thermal stress conditions that will be experienced in the follow-on models."

All tests were successful and the reactor survived every one, Hoffman said.

As a result, he continued, the AEC has decided to eliminate development of the Tory IIA-2. Instead, it will go directly to the Tory IIC—the last step before a flyable powerplant.

Testing of the latter will begin in 1963.

• **Program plans**—In describing the program, the AEC said that design power, operating temperature and the size of the reactor approximate the requirements for a propulsion system needed for flight at sea level.

"The Department of Defense has stated an interest in continuing with a ground-test follow-on program after successful demonstration of the IIC," an AEC statement said.

"Proposals will be invited for participation in the follow-on program which will include development of reactors for ground tests and, when required, for flight test.

"The varied and interrelated functions of the follow-on program including the development of an air frame and reactor and propulsion systems will require close coordination among the participants. We are working with the Air Force to determine the type of management organization which will be best suited to accomplish the program.

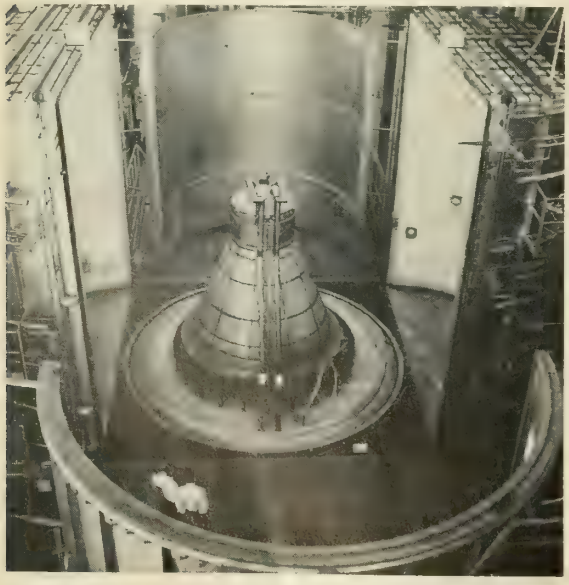
"Also, the Deputy Chief of Naval Operations for development has requested the AEC to undertake studies of nuclear ramjet engines compatible with vehicles which are capable of launch from existing *Polaris* submarines or from other seaborne launch configurations."

• **Strong points**—The ramjet missile can be used either as an ICBM or as an unmanned reconnaissance vehicle.

In listing its advantages, Hoffman said: "All the missiles we have either in being or in development travel the ballistic route. They all have a fixed trajectory in other words, be it the *Polaris, Atlas, Titan* or *Minuteman*. These are calculable. Once you fire one you can calculate back rather rapidly where it came from.

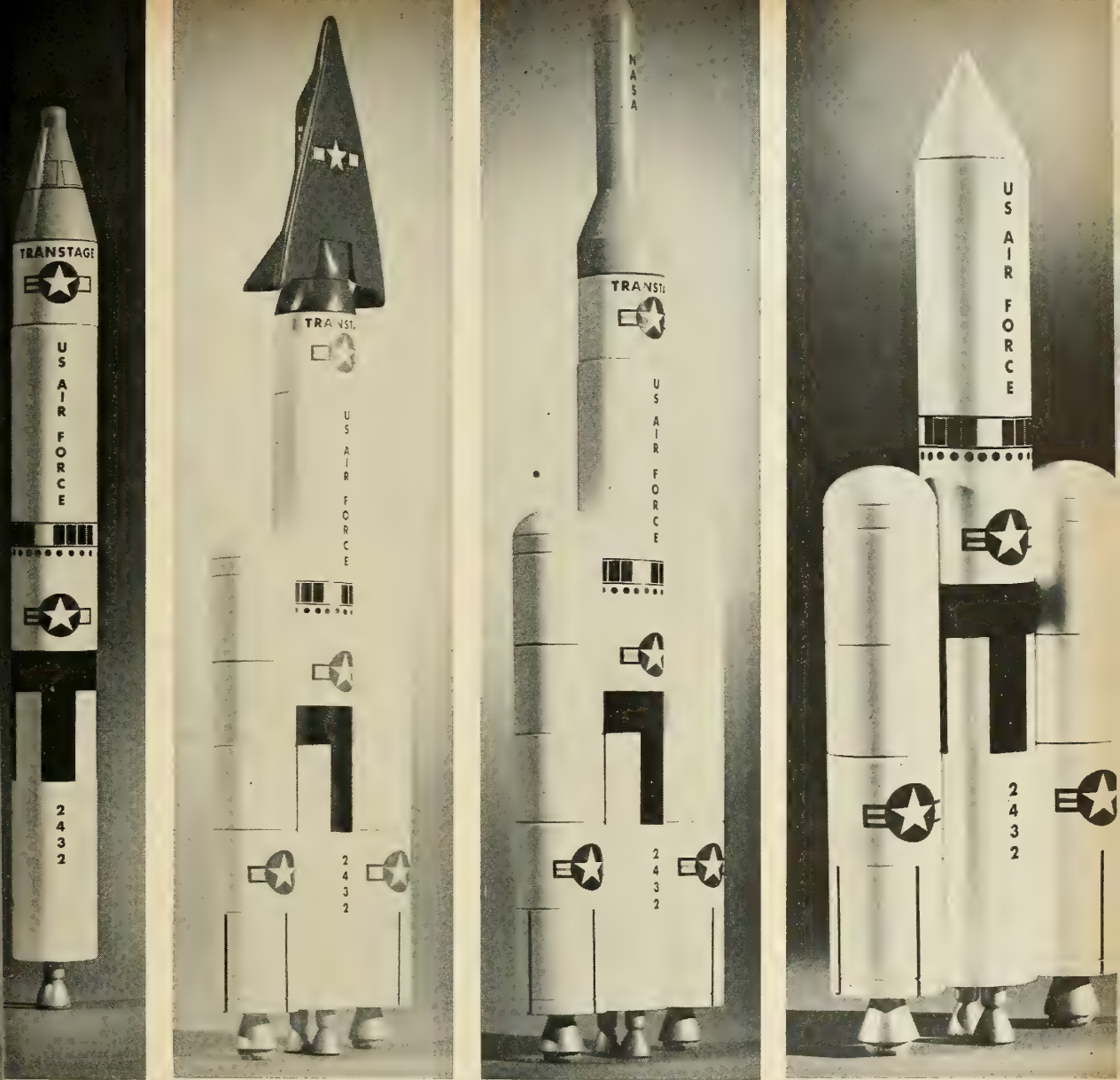
"The missile that would use a nuclear ramjet propulsion system has been designed in preliminary design only at this point by several companies.

(Continued on page 40)



F-1's Mammoth Brazing Furnace

THRUST chambers for 1½-million-lb.-thrust F-1 engine are brazed in this huge gas furnace at Rocketdyne Canoga Park, Calif., plant. Largest of its type in U.S., furnace makes possible use of new high-strength metals.



FROM TITAN II/GEMINI through Titan III/Apollo, first model photos show booster's potential.

The Varied Shapes of Workhorse Titan III

CONFIGURATION details of the Air Force-Martin *Titan III* space booster illustrate the extreme versatility of the solid-liquid launch vehicle.

The flexibility in United Technology Corp.'s segmented solid strap-on boosters is augmented by the Transtage upper propulsion unit—recently awarded to Aerojet-General to complete the *Titan III* industrial team.

The contract award was made public by Sen. Clair Engle's (D-Calif.) office. Five firms competed for the unit, which consists of a small motor assembly designed to provide final velocity and direction to *Titan III* space payloads.

As with the other contractors on the *Titan III* program—UTC, American Bosch Arma, Martin Co.—no final contracts can be awarded until the booster concept receives Department of Defense approval. Martin will be the systems integration contractor for Transtage.

As the photographs indicate, the *Titan III* can be used for manned Earth-orbiting missions, either glide or drag re-entry types. A typical spaceprobe configuration illustrates another capability.

The current *Titan III* development calls for 17 vehicles—12 basic *Titan II's* and 5 full-scale *Titan III's*. Development costs are estimated in the billion-dollar range. The booster concept will be the workhorse for the next decade.

The preliminary design phase has been under DOD review for about two months, together with a firm development plan. ⌗

At Naval Propellant Plant . . .

New Process May Boost Solids' I_{sp}

Rocketdyne-developed continuous inert-diluent method may also cut costs 10%; a look at NPP's growth

by William Beller

SOLID PROPELLANTS in the very-high-specific-impulse range have recently been manufactured on a pilot-plant basis by a new process pointing the way to more powerful solid missiles.

"It is the first new process in solid-propellant production in 15 years," Joe L. Browning, Technical Director of the Naval Propellant Plant, told MISSILES AND ROCKETS.

Developed at Rocketdyne Div. of North American Aviation, Inc., the method is now being applied to production for the first time at NPP.

Engineering estimates indicate that one result may be to push solid-propellant performance nearly one-fifth higher than it is today.

The process was described as a continuous production method which gets rid of much of the hazard of handling large amounts of volatile and sensitive ingredients by using an inert diluent to carry and mix them.

In effect, the solid propellant is manufactured on a liquid production line: at various stations along a pipeline ingredients are added to a liquid carrier which, in turn, mixes and transports them to the final station where the carrier is tapped off.

NPP engineers say they expect to produce propellant grains at about 10% less cost than by competitive methods.

Other advantages:

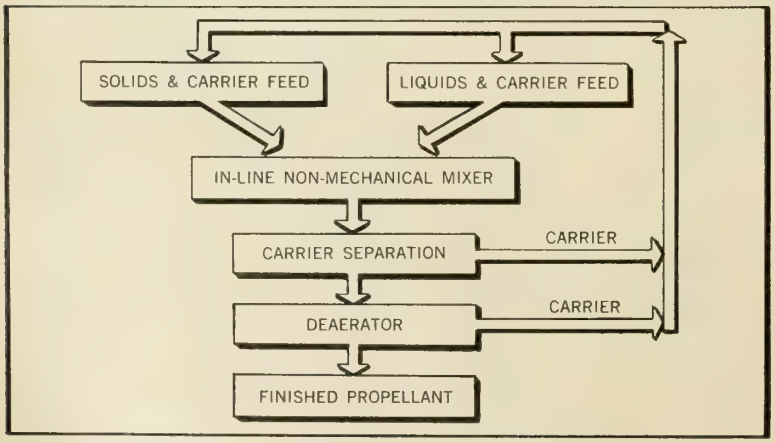
—Since only a small amount of ingredients in a volatile state are in the mix at any one time, materials ordinarily too sensitive to handle can be reconsidered for use in advanced propellants.

—Because the process is continuous, the product will be uniform and propellant performance easier to predict.

—The changeover from one propellant to another can be made quickly and without cleaning the production line, an advantage not offered by individual mixers now in use. As a result, rapid development programs can be undertaken and propellants tailored to meet emergency conditions. There also can be fast responses when large or small amounts of highly sensitive propellants are needed in a hurry.

One disadvantage is that the process cannot be used where the propellant ingredients are soluble in the liquid carrier; this, however, is not a problem that has to be faced at present.

NPP is now laying plans to install the continuous inert-diluent process to make substantially larger than pilot-plant quantities of high-impulse solid propellants, destined for Navy missiles now being developed.



FLOW DIAGRAM of continuous inert-diluent process for making solid propellants. Each connecting line represents an actual pipeline.

• **Get up and run**—The $83-million NPP is today uniquely able to help government and industry solve their propellant problems. This has not always been true.

In 1957, when the establishment was known as the Naval Powder Factory, the Bureau of Ordnance was trying, without too much success, to find reasons to keep the plant open. Conceived in the gunpowder era, the station was not easily making the switch to rockets and missiles.

A year later BuOrd told the station to make something out of itself or close up. Then Joe L. Browning, fresh from the Special Projects *(Polaris)* Office at the Bureau of Weapons, was hired as Director of Research and Development. The station's name was changed to its present one. In 1959, Captain Otis A. Wesche assumed command of NPP.

Those changes helped put NPP into the forefront of solid-propellant research. (The facility also pays attention to liquid propellants, five per cent of its R&D money going into this field.)

• **A major facility today**—Money is one way to measure NPP's growth during the past four years: in Fiscal 1958, NPP's R&D budget for men and materials was $1.8 million; for Fiscal 1962 and probably for Fiscal 1963, the budget is $10 million. The entire budget on the station is about $90 million for Fiscal 1962.

Browning—now Technical Director—said that his chief goal in directing NPP's R&D efforts was to make the station competitive in technical ability with industry. Crediting Capt. Wesche with having done much to get this job done, Browning added, "Now we are in the position where we can support industry, particularly for scaling-up test-tube amounts of sensitive propellants."

The plant is the chief source of rocket propulsion and auxiliary power units for the Navy, and in addition makes units for the other armed services. "Our primary mission is to be

sure the units we devise are producible, reliable and made economically," Browning told M/R.

Part of the R&D program is to guide the Navy into the most promising technical areas for propellant developments. Another part is to advise the Bureaus whether manufacturers' proposals live up to Navy's specifications.

NPP is most proud of its ability to work quickly in the face of changing conditions or requirements. Some examples:

—To scale-up a new high-energy oxidizer from grams/hour to a production of pounds/hour—two weeks.

—To change a laboratory model of a new propellent system into a 40-lb. motor undergoing a firing test—12 weeks.

—To set up a remotely controlled processing laboratory—five days.

—To increase production effort 50% to meet Fiscal 1962 supplemental program—12 weeks.

• **Aid to government and industry**—NPP is setting up a propellant safety program, intended to give government and industry the benefit of the station's experience. There is no charge for this service, which will become increasingly necessary as higher-energy systems are designed.

NPP also acts as a supplier for any ingredients produced by the station. Typical ones are nitroplasticizers and metriol trinitrate, which the government and industry buy.

"We have men who get their hands dirty," boasted Browning. "These men take propellant ingredients that are in the 'awkward' or test-tube stage and provide a scale-up of the materials so that industry can put them into propellant systems." The companies already aided in this way read like a "Who's Who" in propulsion—including Aerojet, Thiokol and Lockheed Propulsion.

NPP contends these are jobs not being taken away from industry. "We're geared for short runs of below 5000 pounds," said Browning. "If the Navy wanted to give such jobs out under contract, it would have to build special plants for industry. Besides, we can usually finish a short run in the time it would take to let a contract."

He continued: "We try to give industry the jobs that are profitable to them and economical to the government."

• **High-obsolescence field**—Browning pointed out that there will have to be major revisions in industry's production equipment for making solid propellants if it wants to keep up with technology.

"There's been an order-of-magnitude change in propellant sensitivity over the past several years," he said. "Prior to 1958 we never manufactured propellants with impact sensitivities less than 60 cm. (distance a five-kg weight drops onto a propellant mass without detonating it); now we have to accept sensitivities less than six cm."



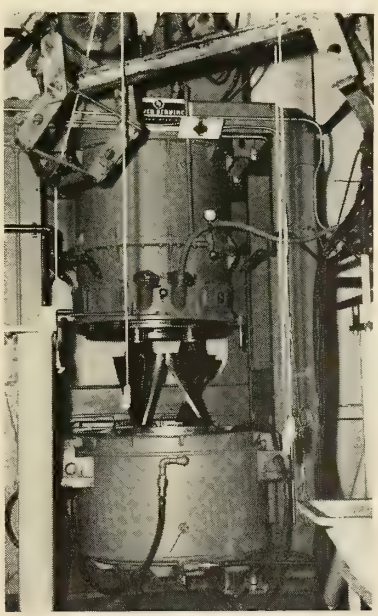
CAPT. Otis A. Wesche, NPP comander.



TECHNICAL director Joe L. Browning.

It is equally clear to NPP that it, too, has to get new facilities if it wants to advance in the field of modern propellants. Five of the station's workmen were killed in a mishap last year.

An accident is not an unusual occurance in either government or industry installations when men are producing propellants. Nevertheless, this points up the hazards of the business and the continuing need for safety measures to keep pace with propellant sensitivity. The relationship, moreover, is far from a linear one.



150-LB. remote-controlled batch-mixer used in NPP pilot plant for scaling up highly sensitive propellant ingredients.

• **R&D work for industry**—NPP is trying to bring its outside R&D contract budget up to 30% of its total R&D budget, and correspondingly increase its R&D budget. "We want to help ensure that the government is getting the most for its research dollars," said Browning. At the same time, he wants to keep a strong research arm at NPP for its own sake and also to be capable of advising BuWeps.

About $500,000 went to contractors for R&D during Fiscal 1962: Olin-Mathieson for characterizing and making a new ingredient for propellants; Monsanto for a new propellant concept; Newbrook Machine for a new method for incorporating propellant ingredients; and Reaction Motors for evaluating a liquid monopropellant for underwater application.

The station is continuously interested in unsolicited proposals but they should be submitted through BuWeps.

Out of the total station budget of $90 million, 35% is used to buy materials—igniters, nitrocellulose, sulfuric and nitric acid. Salaries account for the rest of the money.

The work of NPP does not end with checking out the products of manufacturers. The station is also charged with the Fleet Quality Surveillance Program—a service of monitoring the operational usefulness of all Navy missiles.

This completes the cycle — from propellant concept through pilot-plant production and then production manufacturing; up to the time the rocket motor is fired in operational use and NPP gets information back. ⌘

To warn astronauts . . .

Apollo In-flight Monitor Proposed

MINNEAPOLIS—An in-flight checkout device aimed at warning astronauts of impending system failures within their space capsule is being put together by Minneapolis-Honeywell engineers.

The device, called Micro Ace (Microminiature Automatic Checkout Equipment) is basically a multi-system miniaturized airborne version of the ground-test equipment Honeywell is building to support its *Apollo* stability and control system (SCS) hardware.

Honeywell engineers report the two-year company-funded effort to develop Micro Ace has now progressed to a working breadboard model, and the system has been proposed to North American Aviation for consideration in the on-board maintenance scheme for *Apollo*.

• **How it works**—Basically, what Micro Ace would do, Honeywell says, is sample performance at a number of major test points on each spacecraft subsystem, using normal operating signal levels scanning the outputs fast enough to approximate simultaneous sampling. The on-board digital computer would then calculate the operational performance of these systems by measuring input-output voltage ratios and system transfer functions, and compare the levels with predetermined high-low voltage levels stored in the computer.

If all systems were "go," a green light would be continuously shown on the crew display. Any deviation out of system tolerances would bring on a red "no go" light with a digital readout device providing the crew automatically with a predetermined degree of fault isolation. In this manner, company officials assert, the astronaut would know immediately which system was not working properly or was about to fail, and the crew could observe system performance trends which would enable them to predict failures in advance and replace faulty modules prior to any in-flight disruption.



ENGINEER puts final touches on breadboard version of Honeywell-proposed in-flight monitoring system for Apollo. Miniaturized version reportedly will be reduced to one-third this size.

As envisioned by Honeywell, the system would supply information on system malfunction automatically, down to a certain fault isolation level, with the astronauts then going through a manual "pushbutton" sequence, somewhat similar in theory to that used in multi-system aircraft analyzers, to pinpoint the trouble.

• **Other factors**—However, exactly how detailed the final automatically acquired fault isolation will be for the spacecraft crew is to a great extent dependent on current human factors studies and the final *Apollo* capsule configuration.

Determinations must be made of the degree of astronaut freedom to make manual repairs, the accessibility of replaceable modules, the component packaging schemes, quantity and types of spare parts to be carried aboard, and the weight, volume, and cost of installing an even more complex fault isolation system.

According to engineers at the firm, Micro Ace can sample up to 50 test points per second. The digital system is designed around modularized microminiature NOR circuits, 1 in. x ¾ in. x 1/10 in. in size, each containing 6 transistors, 4 diodes, and 27 resistors. Though the system is virtually free of inductors and large capacitors, some of the latter are employed in the breadboard; this poses a problem concerning microminiaturization of the entire package.

The system also will reportedly use all-high-speed solid-state switching, with newly developed solid-state circuits which are said to provide very slight low-signal degradation.

The Honeywell system is also designed with a built-in-test feature which can monitor the Micro Ace reference voltages and verify switching function in order to assure that any failure indication is a reflection of the spacecraft system rather than the maintenance device.

The test equipment being developed by Honeywell to support the *Apollo* stability control system consists of a bench test unit and a smaller system tester used to check out completed and installed hardware.

The systems checker includes a control and display unit and a small computer capable of supplying test stimuli through 150 control system test points and comparing results to programed limits. Honeywell says this equipment is scheduled to be available by March 1963. Company officials also reported that the SCS checkout gear could be adapted to multi-system usage for possible ground support of other *Apollo* equipments.



IMP Glider To Check Flux

ARTIST'S concept of Inflatable Micrometeoroid Paraglider (IMP) being built by Space-General for NASA to measure micrometeoroid flux in near-space.

ASTROLOG

Current status of U. S. missile and space programs plus all orbiting satellites



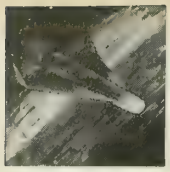
Missiles

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
ALFA (Navy)	Navy, prime; Avco, air frame	ASW surface-to-underwater; 500 lb. solid; conventional	Operational; deployed on destroyer escorts
ASROC (Navy)	Minneapolis-Honeywell, prime; Sangamo Electric, sonar; torpedo, GE; Librascope-General Precision, fire control	ASW surface-to-underwater; solid nuclear or conventional, range about 8 miles; advanced ASROC (improved Mark 44 torpedo) under R&D	Operational on destroyers, destroyer escorts, heavy cruisers and guided missile frigates.
ASTOR (Navy)	Westinghouse, prime	Mark 45 ASW underwater to underwater wire-guided torpedo; nuclear or conventional	Operational on hunter-killer submarines
ATLAS (Air Force)	GD/Astronautics, prime; GE/Burroughs, Arma, guidance; Rocketdyne, propulsion; GE/Avco, re-entry vehicle; Acoustica, propellant utilization	ICBM; 5500-to-9000 mile range; liquid; nuclear; ATLAS "E" and "F" series have inertial guidance; earlier ATLAS "D" has radio inertial; proposed ATLAS "G" would have 900,000-lb. thrust and 4000-lb. payload capability	Operational; 13 squadrons planned at 4 bases; already emplaced at Vandenberg, Warren, Offutt, Fairchild and Forbes; total of 54 launchers operational, ATLAS F being tested
BOMARC IM-99A (Air Force)	Boeing, prime; IBM/Westinghouse, guidance; Aerojet/Marquardt, propulsion	Ramjet surface-to-air interceptor; liquid booster; 250 m. range; Mach 2.7; nuclear	Five bases operational in Northeastern U.S. from Virginia to Maine, production completed
BOMARC IM-99B (Air Force)	Boeing, prime; Kearfott/Westinghouse, IBM guidance; Thiokol/Marquardt, propulsion	Ramjet, surface-to-air; solid booster; Mach 4; more than 400 m. range; nuclear	First base operational May, 1961; two more planned; A-squadrons will be strengthened with advanced B model
BULLPUP GAM-83, ASM-N-7A (Navy-Air Force)	Martin, prime; Martin, guidance; Thiokol, Naval Propellant Plant, propulsion; Maxson, second-source prime	Air-to-surface; 3-6 mile range; radio-guided conventional 250-1000-lb. bomb; BULLPUP B: nuclear warhead and I pre-packaged liquid motor; nuclear-tipped model nearly operational	Deployed with Atlantic and Pacific Fleets; operational with Air Force units. Marines launching BULLPUP from helicopters.
★**CORPORAL** (Army)	Firestone, prime; Gilfillan, guidance; Ryan, propulsion	Surface-to-surface; 75-mile range; liquid; nuclear; command guidance	Deployed with U.S. & NATO troops in Europe. SERGEANT to replace CORPORAL beginning in FY' 63
DAVY CROCKETT (Army)	In-house project directed by Rock Island, Ill., arsenal	Surface to surface; solid; bazooka launched; sub-kiloton nuclear warhead; two launchers: vehicle mounted or carried by two men	Operational in Europe; FY '63 budget funds for majority of inventory objective
★**ENTAC** (Army)	Nord Aviation, prime	Antitank; 6600-ft. range; 37 lbs.; HE warhead; wire-guided; man-portable	Operational; Army buying from French in quantity to replace SS-10
★**FABMDS** (Army)	GD/Astronautics, Hughes, Martin, GE, Raytheon, Sylvania—feasibility studies	Mobile antimissile defense system to provide an effective defense of the field army against enemy ballistic missiles	Feasibility studies submitted to ARGMA last year; evaluated by experts; future in doubt due to DOD doubts of its effectiveness
FALCON GAR-1, 10, 2, 2A, 3, 4, 9, 11 (Air Force)	Hughes, prime; Hughes, guidance; Thiokol, propulsion	Air-to-air; 5-mile range; Mach 2; solid; conventional; GAR-11 model has nuclear warhead	Operational; buy-out of GAR 3A, 4A and 11 in FY '62; GAR 9 under continued development
★**GENIE** MB-1 (Air Force)	Douglas, prime; Aerojet-General, propulsion	Air-to-air; unguided; 6-mile range; nuclear solid rocket; supersonic; proximity fuzing	Operational on F-101B & F-106 fighter-interceptors
HAAW (Army)	AOMC, prime	No details; Heavy antitank/assault weapon	Development; funds in FY '63 budget
★**HAWK** (Army)	Raytheon, prime; Raytheon, guidance; Aerojet-General, propulsion	Surface-to-air; 22-mile range; solid; conventional; provides defense against medium and low-flying aircraft and cruise-type missiles; improvements in system to be phased into production and furnished as modification kits to existing equipment	Operational; deployed in Europe, Panama, Okinawa, U.S. (13 battalions); '63 procurement will essentially complete deployment objective; Marines also procuring system
HONEST JOHN (Army)	Douglas/Emerson Electric, prime; Hercules, propulsion	Surface-to-surface; unguided; 12-mile range; nuclear; 5800 lbs.; ADVANCED HONEST JOHN has increased performance, lighter and smaller; also developed a lighter-weight mobile launcher and an air-transporter launcher	Operational; deployed in Europe; to be replaced by MISSILE B

★ **Indicates changes since May, 1962, Astrolog**

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
HOUND DOG GAM-77 (Air Force)	North American, prime; Autonetics, guidance; Pratt and Whitney, propulsion	Air breathing air-to-surface; standoff missile; 500-mile range; Mach 1.7; turbojet; nuclear; B version in production	Operational; to be launched from B-52G intercontinental bombers; stockpile expected to exceed 400
JUPITER SM-78 (Air Force)	Chrysler, prime; Sperry Farragut, guidance; Rocketdyne, propulsion; Goodyear/CLT, re-entry vehicle	IRBM; liquid; nuclear range: over 1500 mi.; guidance: all-inertial	Operational in Italy (30 launchers) with Italian AF; also deployed in Turkey;
LACROSSE (Army)	Martin, prime; Martin, guidance; Thiokol propulsion	Surface-to-surface; highly mobile; 20-mile range; solid; nuclear	Operational; three units in Europe; eight planned; to be replaced by MISSILE B
LITTLE JOHN (Army)	Emerson Electric, prime; Hercules Powder, propulsion	Surface-to-surface; unguided; 10-mile range; solid; nuclear; supplements medium and heavy artillery in airborne divisions and air-transportable commands	Two battalions activated in '61; each equipped with four launchers
M72 (Army)	Hesse-Eastern Div., Flightex Fabrics, prime	Light antitank rocket; carrier tube launcher; 4.5 lbs.; 25 in. long/3 in. diameter; range 500 yd.; replaces 3.5 in. rocket launcher and rifle grenade; before type classification system known as LAW	Operational
★**MACE** (TM-76) (Air Force)	Martin, prime; Goodyear/AC Spark Plug, guidance; Thiokol/Allison, propulsion	Air-breathing surface-to-surface; more than 650-mile range; turbojet & solid-nuclear; B model has more than 1200 mile range; inertial guidance in MACE B	Two MACE-A and one MACE-B squadron deployed with U.S. troops in West Germany; hardened facilities under construction in Germany; to be in Okinawa, Korea; replaced MATADOR in U.S. arsenal
MATADOR TM-61C (Air Force)	Martin, prime; Thiokol/Allison, propulsion	Air-breathing surface-to-surface; 500 mile range	Being turned over to West Germans; also deployed in Far East
MAULER (Army)	GD/Pomona, prime; Hughes, guidance; Lockheed, propulsion; DeHaviland, IR acquisition	Surface-to-air; radar guidance; highly mobile antiaircraft and antimissile missile for field use;tracked vehicle; 12 per launcher	R&D; NATO may buy; program to be accelerated in FY'63
★**MEDIUM-RANGE BALLISTIC MISSILE** (Air Force)	Guidance: AC Spark Plug and GPI competing for contract requests for proposals out for six separate parts of the missile	Two-stage, solid propellant, stellar-inertial guidance; entire system contained in one mobile vehicle; range: 300-1500 miles	Being restudied at DOD direction; development postponed pending study results; state-of-art missile to be developed in shortest possible time; to be deployed in Europe and Far East. Complex political questions of control within NATO delaying
★**MINUTEMAN** SM-80 (Air Force)	Boeing, major contractor; Autonetics, guidance; Thiokol, propulsion first stage; Aerojet, propulsion second stage; Hercules, third stage; Avco, re-entry vehicle	2nd generation ICBM; solid; deployed in hardened and dispersed silos; nuclear; 3 stages; range: over 5000 miles; guidance: all-inertial	Development; initial procurement late this year; scheduled to be operational mid-1962 at Malmstrom AFB; 3 squadrons at Malmstrom, Mont; Ellsworth, S. D.; Whiteman, Mo.; Minot, N. D.; 16 squadrons through FY '63, more in later years; mobile version killed
M-55 (Army)	Norris Thermador, prime	Four-inch diameter, small, short-range rockets; for delivery of chemical agents; to be fired from 45-tube launchers	Operational
★**MISSILE B** (Army)	AOMC, prime	A highly-mobile general-purpose missile; range 10-50 miles	Funds available in FY '63 budget for initial development; eventually will replace HONEST JOHN and LACROSSE; division support weapon. Bidders Conference held last month, two or more contractors to be named by July 15 for 60-day program definition phase; contract for development probably will be awarded in October.
NIKE-AJAX (Army)	Western Electric, prime; Western Electric, guidance; Thiokol, propulsion; Douglas, airframe	Surface-to-air; 25-mile range; Mach 2.5; solid & liquid; conventional	Deployed in U.S., Europe & Far East; 19 battalions still operated by National Guard are gradually being phased out
NIKE-HERCULES (Army)	Western Electric, prime; Western Electric guidance; Hercules & Thiokol, propulsion; Douglas, airframe	Surface-to-air; 75-mile range; Mach 3+; nuclear; antiaircraft, tactical missiles; mobile or fixed	Rapidly replacing NIKE-AJAX; well over 80 batteries deployed in U.S.; increasing number to be manned by Army National Guard Units; more than 10 N-H batteries were deployed overseas in 1961; N-H on Formosa
★**NIKE-ZEUS** (Army)	Western Electric, prime; Bell Telephone, guidance; Thiokol/Lockheed, propulsion; Douglas, airframe	Anti-missile; 3-stage; 200-mile range; solid; nuclear	R&D test launchings at White Sands, and Pt. Mugu; complete system tests at Kwajalein later this year; first ZEUS Kwajalein launching Dec. 14
★**PERSHING** (Army)	Martin, prime; Bendix, guidance, Thiokol, propulsion	Surface-to-surface; two-stage solid; approx. 400-mile range; nuclear; transported on FMC XM474 tracked vehicle; proposed PERSHING II would have 1000-mile range	R&D; to replace REDSTONE. Procurement to begin this year; W. Germany buying; first battalion activated last month
POLARIS (Navy)	Lockheed, prime; GE/MIT, guidance and fire control; Aerojet-General, propulsion; Lockheed, re-entry vehicle	Underwater and surface-to-surface; solid; 1200-n.m. range; A-1 installed aboard first six submarines; nuclear; A-2 (1500 n.m.) aboard submarines 7-19; A-3 (2500 n.m.) aboard 20th and all subsequent subs; possible A-4 4000-5000 mile range missile under study. Total POLARIS submarine program: 41 with six being added during FY '63 and final six during FY '64	Five subs each with 16 missiles operational. A2 scheduled to be operational in 1962; A3 in 1964
QUAIL (Air Force)	McDonnell, prime; Guidance Technology, Inc. guidance; GE, propulsion; Ramo-Wooldridge, ECM equipment	ECM-carrying bomber decoy; about 200 m. range; turbo jet powered advanced version with 400 mile range has been flight tested	Deployed at SAC bases; carried by B-52; procurement completed FY '61
★**REDEYE** (Army)	GD/Pomona, prime; Philco/General Dynamics/Electronics, guidance; Atlantic Research, propulsion	Surface-to-air; 4-foot, 20-lb. bazooka-type; IR guidance; solid; conventional; container-launcher disposable for use against low flying aircraft	Development, plans for full production modified because of unsatisfactory tests; limited numbers will be procured in both FY '62 & '63; Marines also buying

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
REDSTONE (Army)	Chrysler, prime; Sperry Farragut, guidance; Rocketdyne, propulsion	Surface-to-surface; liquid; 200-mile range; nuclear	Deployed with U.S. troops in Europe; to be replaced by PERSHING
REGULUS I (Navy)	Chance Vought, prime and guidance; Aerojet-General, propulsion	Surface-to-surface; turbojet & solid; 500-mile range; nuclear	Deployed aboard U.S. submarines and cruisers; KDU-1: drone version; modernization program initiated during FY '61 to retrofit missiles with airborne guidance; retrofit to be completed by end of FY '62
★**SERGEANT** (Army)	Sperry, prime; Sperry, guidance; Thiokol, propulsion	Surface-to-surface; solid; more than 75-mile range; nuclear; inertial guidance employs drag brakes in terminal phase of flight	In production; procurement, except for training missiles, to be completed during FY '63; will replace CORPORAL; deployment in Europe in 1963
★**SHILLELAGH** (Army)	Ford Aeronutronic, prime	Surface-to-surface; lightweight; can be vehicle-mounted for use against field fortifications, armor and close-in support of troops	Development; technical difficulties may force radical changes in system
SHRIKE (Navy)	NOTS-China Lake, prime; Texas Instruments, guidance	Air-to-surface; anti-radar; formerly called ARM	Development; first production buy in FY '63 budget
★**SIDEWINDER** (GAR-8) (Navy-Air Force)	GE-Philco, prime; Philco/GE guidance; Naval Propellant Plant, propulsion	Air-to-air; IR guidance; more than 2 m. range; conventional; new 1-C models to have switchable IR and radar-guided warheads and a new and improved rocket motor	Deployed with Navy and Air Force; all-weather type under development; delivery of 1-C version to start early in this calendar year
★**SKYBOLT** GAM-87 (Air Force)	Douglas, prime; Nortronics, guidance; Aerojet, propulsion; GE, re-entry vehicle	ALBM; more than 100-mile range; solid; nuclear; to be launched from B-52 G and H and British Vulcan bombers	R&D; to be purchased by British; operational 1964; air drops from B-52 and Vulcan bombers successful; first R&D flight in April partially successful
★**SLAM** (Air Force)	Ling-Temco-Vought Vehicles, Atomics International Div., NAA/Lawrence Radiation Labs, Reactor; Marquardt, Propulsion	Surface-to-surface; low-altitude; supersonic; nuclear ramjet; designed to conduct long aerial patrols at speeds up to 2000 mph.	Propulsion system being developed under project PLUTO; feasibility proven by highly successful TORY reactor tests; may be answer to DOD requirement for low-altitude missile to get under enemy radar defenses
SPARROW III (Navy)	Raytheon, prime; Raytheon, guidance; Aerojet-General, Thiokol propulsion	Air-to-air; 5-8 mile range; Mach 2.5-3; solid and pre-packaged liquid; conventional	Operational with carrier aircraft, earlier SPARROW I obsolete; production begun on advanced version (SPARROW III B) to be prime armament for F4H-1 interceptor; F3H-2 Demon also to carry III B—presently equipped with SPARROW III and III A
★**SUBROC** (Navy)	Goodyear, prime: Kearfott, guidance; Thiokol, propulsion; Librascope-General Precision, fire control	Underwater or surface-to-underwater anti-submarine missile; 25-30 mile range; solid; nuclear	Operational aboard nuclear-powered attack sub Thresher; reportedly entire system will be tested as part of current U.S. nuclear tests
SS-10 (Army)	Nord Aviation, prime; GE, U.S. licensee	Surface-to-surface; primarily antitank; 1600-yards range; 33 lbs. solid; wire guided; conventional	Operational with U.S., French and other NATO and Western units; battle-tested in North Africa; U.S. replacing with ENTAC
SS-11 (Army)	Nord Aviation, prime; GE., U.S. licensee	Surface-to-surface; also helicopter-to-surface; 3800-yard range; 63 lbs; wire guided; conventional	Operational, to be used with airborne units
★**TALOS** (Navy)	Bendix, prime; Bendix, McDonnell, Allegany Ballistics Lab., propulsion; Farnsworth Electric, guidance	Ship-to-air; 65-mile range; solid & ramjet; Mach 2.5; nuclear	Operational aboard cruisers Galveston, Oklahoma City and three heavy crusiers; Long Beach, first nuclear-powered missile cruiser, to carry advanced TALOS
★**TARTAR** (Navy)	GD/Pomona, prime; Raytheon, guidance; Aerojet-General, propulsion	Ship;to-air 10-mile range; Mach 2; 15 feet long & 1 foot in diameter; solid dual-thrust motor; conventional	Operational; installed aboard 6 guided missile destroyers and as backup on heavy cruisers equipped with TALOS; advanced version with greater range and improved performance available in 1962
TERNE (Navy)	Kongsberg Vapenfabrikk, prime; Arma, systems integration	Surface-to-underwater ASW missile; 264 lbs; HE warhead	Navy buying from Norway to equip two destroyer escorts
★**TERRIER** (Navy)	GD/Pomona, prime; GD/Pomona, Sperry guidance; ABL, propulsion	Ship-to-air; 10-mile range; Mach 2.5; 27 feet long; solid conventional; 2 greatly improved versions now becoming operational	Operational aboard one attack carrier (Kitty Hawk), one light cruiser (Springfield) and six guided missile frigates; also used by Marines for beachhead operations
THOR SM-75 (Air Force)	Douglas, prime; AC Spark Plug, guidance; Rocketdyne, propulsion; GE re-entry vehicle	Surface-to-surface IRBM; 1500-mile range; liquid; nuclear guidance, all inertial	Operational; 4 bases (60 launchers) set up in England.
★**TITAN** SM-68 (Air Force)	Martin, prime; Bell/Sperry, TITAN I guidance; AC Spark Plug, TITAN II guidance; Aerojet-General, propulsion; Avco, TITAN I re-entry vehicle; GE, TITAN II re-entry vehicle	Surface-to-surface ICBM; 5000-mile range; liquid; 90 feet long; nuclear; TITAN I burns LOX-Kerosene; TITAN II has storable propellants, inertial guidance, bigger payload, greater range, 115 ft. long TITAN II to be used as 2nd stage for TITAN III space booster	8 bases for 12 squadrons planned; TITAN I squadron at Lowry AFB declared operational in April; TITAN II scheduled operational early 1963; TITAN I successfully launched from TITAN II silo; first TITAN II test in March successful; second test last month partially successful
★**TOW** (Army)	Feasibility studies awarded to Martin, McDonnell and Hughes	Tube-launched, optically tracked, wire guided, HE warhead	Follow-on to ENTAC; studies are reportedly to end in a feasibility demonstration
★**TYPHON** (Navy)	Bendix, missile; Westinghouse, shipboard control	Medium and long range seagoing anti-aircraft and antimissile missiles with offensive capability against surface ships and shore targets; formerly called SUPER TARTAR and SUPER TALOS; solid booster and ramjet sustainer; conventional; supersonic	Development; successor for TALOS, TARTAR and TERRIER; expense of system may delay deployment. Norton Sound is being converted, and a nuclear powered frigate is being built for the system
WAGTAIL (Air Force)	Minneapolis-Honeywell, prime	Family of airborne RLM's (rear-launched missiles): air-to-air and air-to-surface	Development
★**ZUNI** (Navy)	Naval Ordnance Test Station, prime; Hunter-Douglas, propulsion	5-inch, air-to-surface; solid; unguided; 5-m. range; conventional	Operational; designed for use on jet fighter and attack aircraft

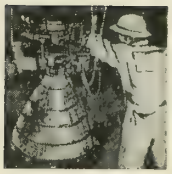


Satellites and Spacecraft

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
★**ADVENT** (Army)	AF, satellite package; Army Signal Corps, ground stations, DCA, Interfaces	Formerly a twenty-four hour instantaneous repeater communications satellite	Re-oriented out of existence. GE, Bendix contracts cancelled. Army responsibility limited to ground stations. AF has responsibility for two new communications satellite systems—a high-altitude, fully-stabilized, 500 lb. successor to Advent and a medium altitude satellite system. Defense Communications Agency has interface problems.
★**ANNA** (Army, Navy, AF, NASA)	In-house Defense program	Geodetic satellite; 50-100 lbs.; spherical; mission: intercontinental surveying using bright flashing light for triangulation	R&D; first launch failed
AEROS (NASA)	No contract announced	24-hour weather satellite earth-stabilized; TV cameras with variable focus; may use SNAP-50 for power	Planning. First flights would be in 1964 or 1965; unfunded FY '62 budget; TV camera R&D to begin soon.
★**APOLLO** (NASA)	North American, Command & Mission Modules, systems integration; MIT, guidance development; tele-communications, Collins Radio; Stabilization & Control, Minneapolis-Honeywell; Environmental control, AiResearch; Parachute Recovery, Radioplane; Escape Tower Rocket, Lockheed Propulsion Co.	Three-man spacecraft for earth orbital, lunar orbital and lunar landing missions. Boosters: SATURN for earth orbits; Advanced SATURN (C-5) for rendezvous; NOVA for direct flight	Earth orbital shots scheduled 1964-65; lunar orbits 1966; lunar landing, 1967-68. Propulsion and orbiting lab module contracts due before mid-62. Final definition of mission profile due this month. If currently favored lunar orbit rendezvous adopted, lunar landing module will probably be scrapped but a lunar exploration vehicle will have to be developed
★**ARENTS** (ARPA)	GD/Astronautics, prime	Satellites to investigate space environment at 22,000-m. and to test long-term behavior of components at this altitude; ATLAS-CENTAUR booster	Contract let to build three payloads; launchings aboard a NASA payload; program reevaluated due to CENTAUR delay. NASA pursuing almost identical program: 3 satellites, 24-hour orbit radiation environment investigations
★**ASP** (Air Force)	No contracts announced	Aerospace plane, a manned spacecraft capable of operating in the atmosphere and space.	Component development program included in FY '63 budget. NASA also interested. But reportedly neither agency is willing to assume budgetary responsibility for a development program
★**BAMBI** (ARPA)	GD/Astronautics, STL	Satellite system capable of intercepting enemy missiles in boost phase using space based platforms and interceptors	Feasibility still unproved; additional research underway
★**DISCOVERER** (Air Force)	Lockheed, prime; GE, re-entry vehicle	THOR-AGENA and ATLAS-AGENA launchings of stabilized satellites; main purpose is to test techniques and components for military space systems	Program life extended; all data on launchings classified as part of New DOD information policy; testing of AGENA D assigned to DISCOVERER program
★**DYNA-SOAR I** (Air Force)	Boeing, spacecraft and systems integrator; Martin, propulsion; Minneapolis-Honeywell, guidance; RCA, communications data link. Project Asset, McDonnell	Boost-glide orbital spacecraft; follow-on to X-15 program; program will demonstrate the capability for positive controlled re-entry and recovery from orbit. TITAN III booster	R&D; program reoriented and suborbital flights eliminated, design details finalized during 1961; Project ASSET will test structural integrity, using BLUE SCOUT; first DYNA-SOAR flight scheduled for 1965
★**ECHO** (NASA)	Langley Research Center, prime	ECHO I: 135 ft. inflatable sphere in 650 mile orbit; passive communication satellite. THOR for ballistic tests; THOR-AGENA for orbital; functioning of sphere will be tested by monitoring its reflectivity to radio waves by measuring its radar cross-section	ECHO I in orbit since Aug. 12, 1960; ECHO II January 1962, failed to orbit; two ballistic shots planned this year from AMR and an orbital launch from PMR
★**GEMINI** (NASA)	McDonnell prime; Rocketdyne, Propulsion	Bigger and heavier MERCURY capsule; to carry two men for periods up to two weeks, TITAN II to be used as booster. 12 spacecraft will be produced. Of the 12 flight missions, 8 will involve rendezvous and docking operations	Development; will be used to determine feasibility of rendezvous for lunar mission; also to test men and components for APOLLO; first unmanned flights, 1963; manned and rendezvous flights, 1964-65
MILITARY TEST SPACE STATION (Air Force)	No contractors announced	Manned Space Station for testing components and techniques in the Space environment	Program not approved for development; but strong indications DOD will approve it in FY '64 budget; AF spending approx. $6 million in FY '63 for studies; NASA also planning orbiting lab for 1966-67 time period
MARINER (NASA)	JPL, prime	450 lbs unmanned spacecraft for early interplanetary missions ;to vicinity of Mars and Venus; boosted by ATLAS-AGENA B	Seven shots planned. First scheduled Venus fly-by Aug. 1962
★**MERCURY** (NASA)	McDonnell, capsule	First U.S. manned satellite; 4000 lbs. + (capsule including escape rocket); boosters: ATLAS and REDSTONE	First manned orbital flight Feb. 20, 1962 by Lt. Col. John Glenn, USMC. 2nd, Cmdr. Scott Carpenter, May, 1962; two more three, or six, orbit flights planned early next year with modified MERCURY capsule

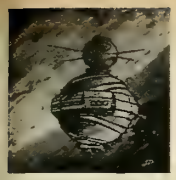
PROJECT	CONTRACTORS	DESCRIPTION	STATUS
★**MIDAS** (Air Force)	Lockheed, prime; Aerojet IR detector system	Early-warning satellite; detect ICBM launchings by IR; R&D models weigh 2.5 tons; operational system 12-15 satellites; plans being finalized for early integration of advanced payloads	R&D; program being re-oriented from precise orbit satellite system to random orbit system; Funds deferred until DOD approves AF development plan. All program data classified by DOD direction
★**NIMBUS** (NASA)	Goddard Space Flight Center Prime; GE, integration and testing	2nd generation weather satellite; earth-stabilized polar orbiting; 650 lbs.; TV cameras and IR scanners in payload; THOR-AGENA B booster	First launching scheduled for late this year; second, six months later; four R&D satellites and four Weather Bureau satellites presently planned
OAO (NASA)	Grumman, prime; Westinghouse, electronic components; GE, stabilization and control	3500-lb. orbiting astronomical satellite observatory equipped with two large telecopes; boosted by SATURN C-1	First flight scheduled in late 1963 or 1964
OGO (NASA)	Space Technology Laboratories, prime	1000-lb. satellites with instruments for geophysical measurements: polar (POGO) and eccentric (EGO) shots planned; ATLAS-AGENA B, THOR-AGENA B, CENTAUR boosters	First flight scheduled in 1963; 19 experiments planned for first shot
★**OSO** (NASA)	Ball Brothers, prime	440-lb. orbiting solar observatory; THOR-DELTA booster, S-16 early version; S-17 and S-57 advanced versions	First flight March 7, 1962, highly successful; first flight for S-17 planned for 1962; satellite stopped sending useful data last month
★**PROSPECTOR** (NASA)	No contract announced	Soft-landed, remote control, unmanned moon exploring or manned-lunar support spacecraft; SATURN booster	Early design phases; mission will essentially be determined by requirements of APOLLO program. Funds eliminated for program by House Space Committee
★**RANGER** (NASA)	JPL, prime; Aeronutronic, capsule; Hercules, retrorocket	300-lb. instrumental capsule rough landed on moon; ATLAS-AGENA B booster	R&D; first two RANGERS failed to launch from orbit; RANGER III launched Jan. 26, failed to impact moon, went into solar orbit; RANGER IV impacted on moon April 26; nine RANGERS planned; all during 1962 and 1963.
★**REBOUND** (NASA)	No contract announced	System of three rigidized multi-launched low-orbit passive communications satellites; follow-on to ECHO. Satisfactory design completed in March.	First orbital flight scheduled for 1963; experiments to be conducted jointly with Air Force; ATLAS-AGENA booster
RELAY (NASA)	RCA, prime	150-lb., spin-stabilized, wide-band, low orbit active repeater experimental communications satellites. Spacecraft will contain two complete and separate communications transponders each capable of handling a standard TV channel. DELTA booster	Britain, France, Brazil and Germany building ground stations; Two launchings planned in in 1962; two more in 1963
★**SATELLITE INSPECTOR** (Air Force)	RCA, prime	Anti-satellite inspection system; to be complemented by interception system; about 2 tons; ATLAS-AGENA B launched	R&D; formerly known as SAINT; during March, 1961, contracts let to design, fabricate and test the spacecraft
SAMOS (Air Force)	Lockheed, prime	Reconnaissance satellite; formerly SENTRY; R&D model weighs 4100 lbs.	R&D; SAMOS II successfully launched Jan. 31 from Vandenberg; scheduled to be operational late 1962; advanced SAMOS under development; all program information classified by DOD direction
SERT (NASA)	RCA, prime	Spinning satellite carrying two electric-propulsion engines for environmental tests	SERT I to be launched last quarter 1962 with Hughes and Lewis Center engines
★**SLOMAR** (Air Force)	Lockheed and Martin, study contracts	Logistics, maintenance, supply spacecraft for space systems	Study contracts awarded in Dec., 1960; DOD studying concepts in connection with Manned Military Space Station
SURVEYOR (NASA)	Hughes, prime	750-lb. spacecraft soft-landing 100-300 lbs. instruments on moon; ATLAS-CENTAUR booster also moon orbiting vehicle planned	First moon flights 1964; seven soft-landing vehicles planned; five lunar orbiters to transmit pictures of the surface also scheduled
★**SYNCOM** (NASA)	Hughes, prime	24-hr. instantaneous narrow band, active repeater communications satellite. DELTA booster; 28 inches in diameter and will weigh about 80-lbs. without weight of injection motor; capable of accommodating one full duplex radio telephone channel; initial inclination to be 30 degrees	R&D; three launchings using THOR-DELTA scheduled during FY '63; advanced SYNCOM with wide band capability (4 TV channels or 300 two-way telephone channels) to be developed in FY '63; 2 flights with Atlas-Agena planned for 1964; one in 1965; remarkably similar to new DOD progam
★**TELSTAR** (AT&T-NASA)	BTL, management for AT&T	125 lb., active repeater, experimental industry communication satellite; DELTA booster. To be launched into 3000 mile orbit	R&D; two to four satellites planned for launch in 1962; first launching has slipped from June to this month by NASA on cost-reimbursed basis
★**TIROS** (NASA-Wea. Bu.)	RCA, prime	285-lb. meteorological satellite; TV pictures of cloud cover; TIROS II and III carried IR scanner. TIROS V doglegged into orbit which will enable satellite to obtain data on ice-breakup in Northern hemisphere	R&D; first launching April, 1960; second Nov. 23, 1960; third last July 12, fourth Feb. 8, all successful; TIROS V successfully launched June 19; two more launches planned; both in 1962
TRANSIT (Navy)	Applied Physics Laboratory, prime	Navigational satellite; R&D model weighs more than 250 lbs.; operational model about 50-100 lbs. THOR-ABLE-STAR booster	4-satellite operational system scheduled to be in orbit by last quarter 1962 to initially be used by POLARIS subs and greatly reduce the position errors of these subs.

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
★**VOYAGER** (NASA)	JPL	Unmanned MARINER follow-on spacecraft to orbit Mars and Venus and to inject a capsule to the surface. Capsule will then communicate with Earth through orbiting spacecraft; SATURN booster; weight approx. 2400 lbs.	Study; design and development to begi this year; first flight planned by 1965
★**X-15** (NASA-AF-Navy)	North American, prime; Thiokol, propulsion	Rocket plane; capable of 4000 mph flight at edge of space; on AF model each XLR-11 rocket engine develops 16,000 lbs. of thrust; XLR-99 engines 50,000 lbs. Three planes delivered; role expanded to include testing of spacecraft components and space research. Current re-entry high angle of attack flights providing basic flight data for DYNA-SOAR program.	Powered flights in progress; plane #1 ha hit Mach 3 and more than 136,500 ft. wit XLR-11 engine; plane #2 with XLR-99 engin turned over to NASA; has hit 4093 mp speed record; altitude record of 250,000 f (unofficial for manned, powered flight



Space Vehicles

★**ADVANCED SATURN** (C-5) (NASA)	S-IB, Boeing; S-II, North American; S-IV B, Douglas; F-1, North American; J-2, North American	S-1B: 5 F-1 engines; S-II; 5 J-2 engines; S-IVB: J-2 engine; 1st stage: LOX/RP; Upper Stages LOX/H_2; 100 ton payload in 345 miles orbit; 43 tons to escape velocity.	R&D; first flight scheduled for 1965; planne for APOLLO missions, if rendezvous—eithe earth orbit or lunar orbit—is adopted fo mission
★**AGENA** (Air Force)	Lockheed, prime; Bell, propulsion	1700-pound upper stage designed to go into orbit with payload; 16,000 lbs. thrust propellants: IRFNA/UDMH; AGENA B has re-start capability. AGENA D to be developed as a standardized upper stage for TITAN III.	Used in DISCOVERER, SAMOS and MIDA programs; AGENA B used with ATLAS an THOR
BLUE SCOUT (Air Force)	Aeronutronic, prime; Minneapolis-Honeywell, guidance; Aerojet/Hercules, Thiokol propulsion	Solid multi-stage booster based on NASA's SCOUT rocket; used as sounding rocket and launching small (approx. 150 lbs.) satellite payloads.	Operational
★**CENTAUR** (NASA)	GD/Astronautics, prime; Pratt & Whitney, propulsion; Minneapolis-Honeywell, guidance	High-energy upper stage using a pair of LOX-liquid hydrogen engines; 30,000 lbs. total thrust, atop ATLAS D booster, capable orbiting 8500 lbs; 2300 lbs. to escape velocity	Development; first flight test failed whe LH_2 tank shielding broke off 54 secs. afte launch
★**DELTA** (NASA)	Douglas, booster; Bell, guidance; Rocketdyne/Aerojet/ABL, propulsion	Successor to THOR-ABLE; upper stage guidance; 3 stage vehicle; 500 lb. payload capability in 345 mile orbit; 60 lbs. to escape	Interim launch vehicle for TIROS-ECHO being used for other satellites and one dee space probe; 26 previously on order aug mented by AF order for 12 more for NAS
NOVO (NASA)	No prime announced; Rocketdyne, 1st stage engine; Aerojet, 2nd stage engine; Rocketdyne, 3rd stage engine	1st Stage: 8 F-1 engines; 2nd Stage: 4 M-1 engines; 3rd Stage: 1 J-2 engine; Payloads: 175 tons in 345 mile orbit; 75 tons to escape; 50 tons planetary probe (liquid)	R&D on 1.5 million lb. F-1 engines; vehicl contracts expected to be awarded this year solid 1st stage may be developed later alternative to advanced SATURN (Rendez vous) and ROVER nuclear rocket
ORION (Air Force)	General Atomic	Space booster by series of atomic explosions	Studies only
★**ROVER** (NASA, AEC)	Lockheed, vehicle prime; Aerojet, NERVA prime, Westinghouse, propulsion	First nuclear rocket: KIWI B	First Rover flight test expected 1966-67 operational vehicle 1968-69
★**SATURN C-1** (NASA)	Marshall Center, S-1 stage, Chrysler Corp.; S-IV, Douglas	2-stage vehicle for early orbital tests of APOLLO and various space programs; 1st stage: 8 Rocketdyne H-1 engines using LOX/RP; 2nd stage; 6 Pratt & Whitney RL10-A3 engines using LOX/H_2; 20,000 lbs. into 345-mile earth orbit	First C-1 launching Oct. 27, '61 from Cap successful; second Apr. 24, '62; both flight with inert upper stage; first flight with liv upper stages 1963; second stage to b launched in 1963
★**SCOUT** (NASA)	Chance Vought prime; Minneapolis-Honeywell, guidance; Aerojet-General/Heicules/Thiokol/ABL, propulsion	Solid four-stage satellite launcher; 150 lb. payload in 345 n.m. orbit; also, used as sounding rocket	SCOUT flights in '61 completed R&D payload capability being increased to 25 pounds
THOR-ABLE-STAR (Air Force-NASA)	STL, prime; Rocketdyne/Aerojet-General/ABL, propulsion	Three-stage vehicle, orbital capability 800 lbs. Upper stage has restart engines	THOR-ABLE phased out. Used in TRANSI and COMPOSITE satellite programs
TITAN III (Air Force)	United Technology, large solid boosters; Martin, TITAN II vehicle; Aerojet, liquid engines; Lockheed, standardized upper stage.	Quick reaction vehicle for military space missions; will be used to boost DYNA-SOAR; 1st stage, 2 120-in. solid motors; 2nd stage, TITAN II (storable propellants); 3rd stage, standardized vehicle, probably AGENA D.	Development; first flight late 1963.



Satellites in Orbit

★**EXPLORER 1** (30.8 lbs.) U.S. Launched 1/31/58, est. life 7-10 years. Orbits earth; perigee 356 km, apogee 1702 km, period 105.6 min. (Discovered Van Allen Belt); not transmitting.

★**VANGUARD I** (3.25 lbs.) U.S. Launched 3/17/58, est. life 200-1000 years. Orbits earth; perigee 651 km, apogee 3942 km, period 133.9; transmitting.

LUNIK I "MECHTA" (3245 lbs.) Russia. Launched 1/2/59. In orbit around sun on 450 day cycle; apogee 1.315 au, perigee 0.9766 au; not transmitting.

★**VANGUARD II** (20.7 lbs). U.S. Launched 2/17/59, est. life 100-250 years. Orbits earth but is "wobbling"; perigee 572 km, apogee 3275 km, period 125.3; not transmitting.

PIONEER IV (13.4 lbs.) U.S. Launched 3/3/59. Orbits sun on 398 day cycle; apogee 1.142 au, perigee 0.9871 au; achieved primary mission—earth-moon trajectory; not transmitting.

★**VANGUARD III** (about 100 lbs.) U.S. Launched 9/18/59, est. life 50-150 years. Orbits earth; perigee 517 km, apogee 3721 km, period 129.8; not transmitting.

★**EXPLORER VII** (91.5 lbs.) U.S. Launched 10/13/59, est. life 30-40 years. Orbits earth; perigee 548 km, apogee 1080 km, period 101.1; not transmitting.

PIONEER V (94.8 lbs.) U.S. Launched 3/11/60, est. life forever. Orbits sun, interplanetary environment probe; completed one full orbit 1/16/61; aphelion .9951 au, perihelion .9061 au, not transmitting.

★**TIROS I** (270 lbs.) U.S. Launched 4/1/60, est. life 50-150 years. Orbits earth; picture-taking weather satellite; perigee 690 km, apogee 751 km, period 99.1; transmitting.

★**TRANSIT IB** (265 lbs.) U.S. Launched 4/13/60, est. life 6 years. Orbits earth; perigee 357 km, apogee 638 km, period 94.5 km. First R&D navigation satellite. Not transmitting.

★**SPUTNIK IV** (10,008 lbs.) Russia. Launched 5/15/60, est. life 2-3 years. Orbits earth; perigee 245 km, apogee 334 km, period 90.3. Test of support systems, cabin, for manned space flight; attempt to return from orbit failed; payload, case and two pieces now in orbit. Not transmitting.

★**MIDAS II** 5000 lbs.) U.S. Launched 5/24/60, est. life 8-15 years. Orbits earth; perigee 474 km, apogee 504 km, period 94.2. Telemetry for IR scanning failed two days after launch. Not transmitting.

TRANSIT II-A (223 lbs.) U.S. Launched 6/22/60, est. life 50-200 years. Orbits earth, perigee 614 km, apogee 1057 km, period 101.6. Transmitting.

★**NRL SOLAR RADIATION SATELLITE I** (40 lbs.) U.S. Launched 6/22/60 with TRANSIT II-A, est. life 50-200 years. Orbits earth; perigee 614 km, apogee 1055 km, period 101.6. Not transmitting.

★**ECHO I** (132 lbs.) U.S. Launched 8/12/60, est. life 2-16 years. Orbits earth; perigee 1547 km, apogee 1709 km, period 118.7. First successful orbiting of passive communication satellite.

★**COURIER IB** (500 lbs.) U.S. Launched 10/4/60, est. life 200-500 years. Orbits earth; perigee 973 km, apogee 1207 km, period 106.9. First successful launching of delayed active repeater satellite. Transmitting.

EXPLORER VIII (90 lbs.) U.S. Launched 11/3/60 by JUNO II, est. life 20-50 years. Orbits earth; perigee 423 km, apogee 2257 km, period 112.4. Provides ionospheric measurements for communications. Not transmitting.

★**TIROS II** (280 lbs.) U.S. Launched 11/23/60, est. life 200-500 years. Orbits earth; perigee 614 km, apogee 736 km, period 98.2. Not transmitting.

SAMOS II (4100 lbs.) U.S. Launched 1/31/61. Orbits earth; perigee 478 km, apogee 541 km, period 94.9. First R&D reconnaissance satellite.

VENUS PROBE (1419 lbs.) Russia. Launched 2/12/61, orbits sun on 300 day cycle; aphelion 1.0190 au, perihelion 0.7183 au.

★**EXPLORER IX** (15 lbs.) U.S. Launched 2/16/61. Orbits earth; perigee 751 km, apogee 2429 km, period 117.9. A 12-ft. "polka dot" balloon.

★**DISCOVERER XX** (2450 lbs.) U.S. Launched 2/17/61. Orbits earth; perigee 252 km, apogee 383 km, period 90.9. No attempt to recover 300-lb capsule because of malfunction.

EXPLORER X (78 lbs.) U.S. Launched 3/25/61. Optical pumping magnetometer. Position uncertain.

★**DISCOVERER XXIII CAPSULE** (2100 lbs.) U.S. Launched 4/8/61. Orbits earth; perigee 179 km, apogee 297 km, period 89.3. Capsule ejected in wrong direction, sending it further into space. Not transmitting.

★**EXPLORER XI** (82 lbs.) U.S. Launched 4/27/61. Orbits earth, perigee 500 km, apogee 1771 km, period 107.8. Measures gamma rays from the stars absorbed in earth's atmosphere.

★**TRANSIT IVA** (IVA, 175 lbs., GREB III, 55 lbs.; INJUN 40 lbs.) U.S. Launched 6/29/61. Orbits earth; TRANSIT—perigee 879 km, apogee 1000 km, period 103.8. GREB-INJUN—perigee 877 km, apogee 1002 km, period 103.8. Transmitting. GREB III and INJUN failed to separate.

TIROS III (285 lbs.) U.S. Launched 7/12/61. Orbits earth; perigee 740 km, apogee 816 km, period 100.3. Transmitting cloud cover weather pictures.

★**MIDAS III** (3500 lbs.) U.S. Launched 7/12/61. Orbits earth; perigee 3374 km, apogee 3516 km, period 161.5. IR early warning satellite.

★**EXPLORER XII** (83 lbs.) U.S. Launched 8/16/61. Orbits earth, perigee 796 km, apogee 76,715 km, period 1589.7. Study Van Allen belts and energetic particles in space.

MIDAS IV (3500 lbs.) U.S. Launched 10/21/61. Orbits earth; perigee 3511 km, apogee 3740 km, period 166.0. IR scanning early-warning satellite.

★**DISCOVERER XXXIV** (2100 lbs.) U.S. Launched 11/5/61. Orbits earth; perigee 244 km, apogee 769 km, period 94.8. Malfunction in orbit forced abandonment of usual attempt to recover capsule.

★**TRANSIT IVB** (200 lbs.) U.S. Launched 11/15/61. Orbits earth; perigee 905 km, apogee 1158 km, period 105.6. Satellite is an operational prototype of the Navy's navigational satellite. Transmitting.

★**TRAAC** (200 lbs.) U.S. Launched 11/15/61 piggy-back on TRANSIT IVB. Orbits earth; perigee, 943 km, apogee 1121 km, period 105.6. Designed to test new system of stabilization based on the earth's gravitation field. Also designed to supply data on the Van Allen belt. Stabilization test still in doubt. Transmitting.

★**RANGER III** (727 lbs.) U.S. Launched 1/26/62. Orbits sun on 406.4 day cycle; probe failed to impact, went into heliocentric orbit; aphelion 1.163 au,. perihelion, 0.9839 au. Not transmitting.

★**TIROS IV** (285 lbs.) U.S. Launched 2/8/62. Orbits earth; apogee 849 km, perigee 704 km, period 100.3; weather satellite to gather cloud cover pictures and IR heat balance data.

★**ORBITING SOLAR OBSERVATORY** (440 lbs.) U.S. Launched 3/7/62. Orbits earth; perigee 550 km, apogee 592 km, period 95.9; payload consisted of 13 experiments to study solar radiations, investigate dust particles in space and thermal radiation characteristics of spacecraft surface materials. No longer sending useful data due to stabilization failure.

COSMOS II (?) Russia. Launched 4/6/62. Orbits earth; perigee 217 km, apogee 1444 km, period 101.4; second in a series of space environmental research satellities; transmission data not known.

★**COSMOS III** Russia. Launched 4/24/62. Orbits earth; perigee 228 km, apogee 659 km, period 93.4; third of a series and intended to study weather, communications and effects of radiation on man during prolonged space flights.

★**UNIDENTIFIED SATELLITES** U.S. Five payloads launched 2/21/62 (THOR-AGENA B), March 7 (ATLAS-AGENA B), April 9 (ATLAS-AGENA B) and April 17 (THOR-AGENA B), April 26 (BLUE SCOUT) April 26 (ATLAS-AGENA B); no data available on orbit or even whether satellites achieved orbit in line with new DOD news blackout; presumably all but the BLUE SCOUT payload were Discoverer, Midas or Samos satellites.

ARIEL: INTERNATIONAL SATELLITE (132 lbs.) U.S.-U.K. Launched 4/26/62; perigee 404 km, apogee 1198 km, period 100.8; first joint satellite (U.K. built payload; U.S. supplied booster, satellite structure and tracking facilities) to study the ionosphere and the intensity of cosmic radiation. Transmitting.

COSMOS V (?) Russia. Launched 5/28/62. Orbits Earth: perigee 193 km, apogee 1569 km, period 102.5; another Soviet satellite for space environmental research. Transmitting.

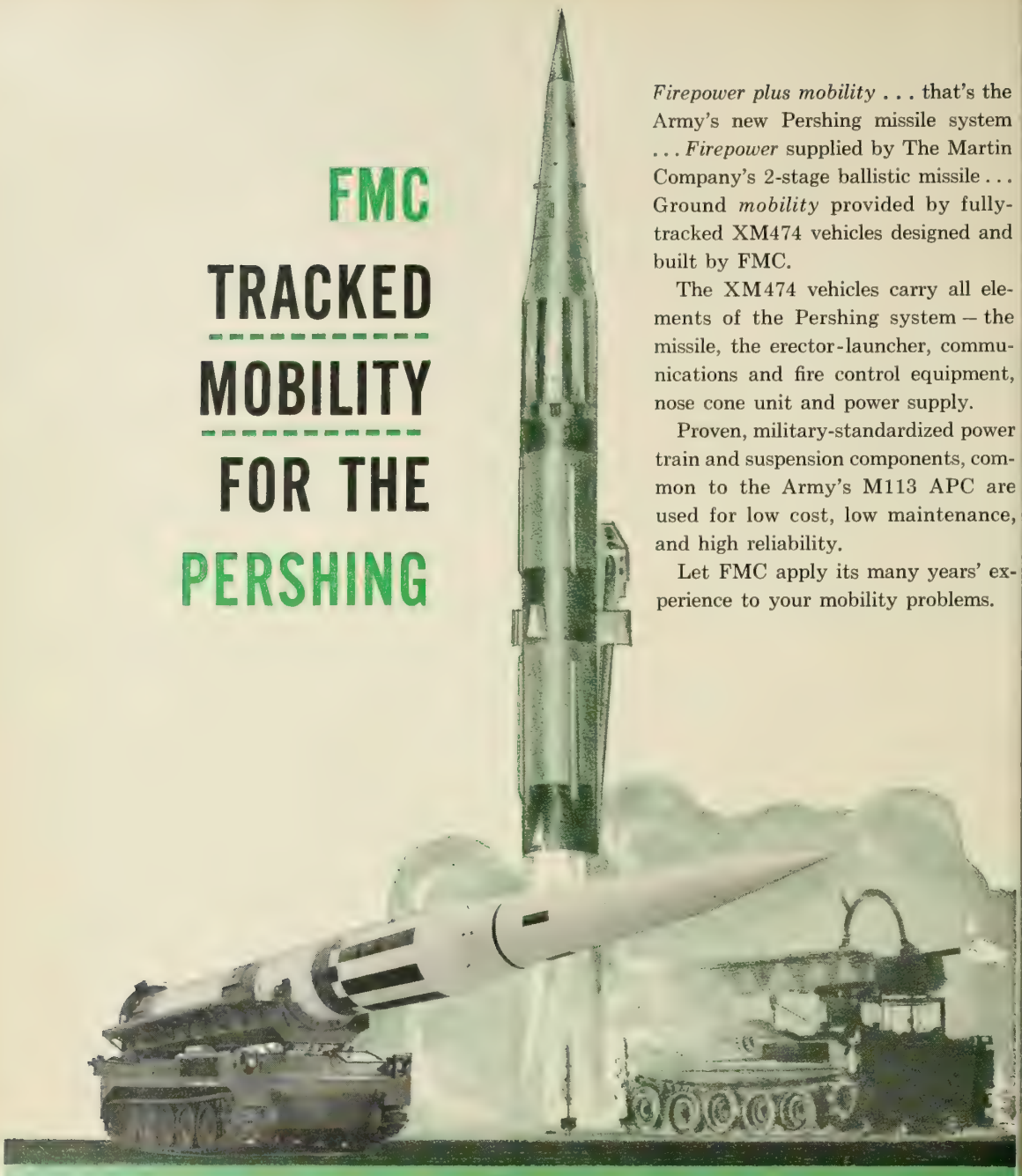
OSCAR II (10 lbs.) Launched 6/2/62. Orbits Earth: perigee 208 km, apogee 386 km, period 90.5. Amateur radio operator satellite launched by AF piggy back on a classified payload.

TIROS V (285 lbs.) Launched 6/19/62. Orbits Earth: perigee 587.2 km, apogee 966.4 km, period 100.5. Weather satellite expected to provide data on the breakup of ice in northern latitudes as well as on the growth of hurricanes. Transmitting.

SECRET AF SATELLITES:

- Launched 3/7/62. wt. unk. ATLAS-AGENA B. Orbits Earth: perigee 239 km, apogee 633 km, period 93.4.
- Launched 4/9/62. wt. unk. ATLAS-AGENA B. Orbits Earth: perigee 2814 km, apogee 3380 km, period 153.0.
- Launched 5/15/62. wt. unk. THOR-AGENA B. Orbits Earth: perigee 293 km, apogee 637 km, period 94.0.
- Launched 5/30/62. wt. unk. BLUE SCOUT. Orbits Earth: perigee 196 km, apogee 319 km, period 89.7.
- Launched 6/2/62. wt. unk. THOR-AGENA B. Orbits Earth: perigee 211 km, apogee 388 km, period 90.5. Carried OSCAR II into orbit.
- Launched 6/17/62. wt. unk. THOR-AGENA B. Orbits Earth, no other data given.
- Launched 6/18/62. wt. unk. ATLAS-AGENA B. Orbits Earth, no other data given.

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ELECTRONICS

MITRE to Assist NATO in Air Defense

The Department of Defense is expected to announce soon the establishment of a MITRE Corp. advisory group to NATO which will be located in Paris. Five top MITRE personnel plus 10 carefully selected consultants from industry will comprise a team which will assist NATO in strengthening its European Air Defense System, M/R has learned. Selection of the industry team will be completed by mid-July. The one-year study effort should lead to development of a plan for a more effective air defense network. Following this, a contract for SEMO (System Engineering and Management Organization) will be awarded by DOD to implement the MITRE recommendations.

Hughes Pumps Maser with Laser

The amplification and generation of microwave radiation in a ruby maser pumped optically by the output from another ruby laser has been accomplished by scientists at Hughes Research Laboratories. The laser-maser pumping technique opens the way to practical use of frequencies previously inaccessible—those between the highest obtainable microwave (200 kmc) and the lowest laser frequency in the infrared (30 mmc). The breakthrough, resulting from a $100,000, one-year research program for the Army Signal Corps, actually is the original goal sought by Hughes when it succeeded in building the first working laser in July, 1960.

Automatic Geodetic Sketcher Developed

The transference of mapping data, obtained by airborne side-looking radar photography, to plot sheets can be performed by a new radar sketching instrument. Developed by Aero Service Corp. for the Army, the unit accommodates transparencies of any size up to 9.5 in. square. Up to a 10% scale differential between the longitudinal and transverse axis is introduced by the Aero system. This, the company says, compensates for large-scale distortions occurring along the longitudinal axis and caused by incorrect ground speed inputs at the time of radar observations.

SPADATS Effort Trebled

NORAD's Space Detection and Tracking System now handles roughly three times the number of Earth-orbiting objects that it did when it first became operational a year ago. In July of last year, SPADATS catalogued and kept track of some 120 man-made space objects. Now, over 300 targets are followed at all times, Air Force officials say.

Pneumatic Gyro Developed

Except for a single optical pickoff, an all-pneumatic gyroscope has been built by ITT Federal Laboratories. The device is a two-axis free inertial reference. Composed essentially of three major parts—a spherical quartz rotor, rotor case and support system, and an outer case—the gyro is driven by a gas impulse turbine. Both the rotor and rotor case are supported by gas-lubricated bearings. Advantages of the new device, ITT designers say, include elimination of conventional gimbals, no thermal problems, instant start-up time, and extremely long life and low drift rate.

Mid-course Correction Suggested for ICBM's

The use of mid-course radio guidance would increase ICBM accuracy by at least an order of magnitude, according to two General Electric engineers. Further, they stressed in a report before last week's Military Electronics Conference in Washington, only very inexpensive unmanned ground stations would be required for transmitting trajectory corrections. Their computations showed that attitude control and propulsion requirements would be less than 3% of gross midcourse vehicle weight. Guidance system weight could be held to 100 lbs., they stated.

ADVANCED MATERIALS

Closed Circuit TV Aids Welding

An air-cooled, shielded TV camera mounted on a traveling boom monitors the inside weld during joining operations on *Minuteman* motor cases at Avco's Lycoming Division. The set-up allows internal welding without subjecting the operator to the intense heat within the chamber. The TV picture is almost 4 times life-size and a special red lens eliminates the blinding welding glare. With the process, welding time has been cut appreciably.

Subminiaturized Neutron Detector Perfected

General Electric engineers have developed a titanium ion chamber weighing less than 0.1 grams, 0.5 in. long and 0.1 in. wide. The tiny unit can be used for external radiation monitoring in satellites or for internal purposes in nuclear space systems. The chamber is designed to withstand the high temperatures of in-core checking of reactor radiation levels.

Olive Drab Missiles Again?

A missile camouflage paint produced by the Army Engineers' Research and Development Laboratories reflects a major percentage of incident solar radiation. Employing newly developed green pigments, the paint will obviate the need for painting missiles white to control heat absorption.

PROPULSION

Cape Complex 34 To Be Altered

Saturn launch complex 34 at Cape Canaveral will be expanded to include liquid hydrogen fueling facilities. Work includes liquid hydrogen storage tanks, high-pressure storage facilities, additional electric power and installation of more blast proofing for the automatic ground control building. Bids on the $1.5-million job will be opened by the Corps of Engineers in Jacksonville, Fla., on July 31. All work must be completed by Jan. 15, 1963.

X-20 Acceleration Rocket Fired

Thiokol Chemical Corp.'s acceleration rocket, designed for the *X-20* glide re-entry vehicle (formerly *Dyna-Soar*) has been successfully static-fired. The test demonstrated that the solid motor will deliver the performance required for two *X-20* missions. The unit will provide an escape capability to the *X-20* in the event of booster malfunction and will be used to accelerate the glider to supersonic speeds in B-52 air-drops. Heavier flight-weight motors will be tested separately.

Fairchild's $2-Million Space Lab Investment

by Michael Getler

SYOSETT, N. Y.—Fairchild Camera and Instrument Corp.'s new space environment laboratory (M/R Nov. 7, 1960, p. 32) is a uniquely engineered center for performance testing of surveillance and mapping systems under several simulated special extremes.

The lab, under development for two years, represents a $2-million investment. It went into operation early this month at the firm's headquarters here.

Key element in the multi-level complex is a huge 3000-cu.-ft. ultra-high vacuum chamber which has reportedly exceeded design specifications and produced pressures of 4×10^{-9} mmHg, equivalent to about 380 miles altitude. Original specs on the 15 ft. x 13 ft. x 14 ft. stainless steel chamber called for pressures of 1.3×10^{-8}.

The chamber evacuation technique employs six 32-in. oil diffusion pumps, a series of ultra-high vacuum valves, and liquid nitrogen traps. During tests of chamber capabilities, pumpdown from atmosphere to 10^{-3} torr was reportedly accomplished in 7 minutes, 10^{-5} in 10 minutes, 1×10^{-8} in 19 hours, and maximum recorded pressure in roughly 100 hours.

The 55-ton chamber, built by the NRC Equipment Corp., Newton, Mass., is said to be capable of temperature control between —100°F and 300°F, and is also designed to accept a 15-ton vibration exciter which can operate at altitudes to 300,000 ft.

The shaker, made by MB Electronics Division of Textron Electronics, Inc., is moved into the chamber on rails by a powered gantry and can supply 28,000 force-lbs. from 5 to 2000 cps and 13,000 force-lbs. to 3000 cps. Maximum acceleration for the device is 78 gs.

• **Photo-optical**—Directly beneath the environmental chamber is a 35-ft. deep underground installation which houses a specially designed 13-ton photo-optical test structure.

The entire photo-optical system is mounted on rails and can be positioned under the environmental chamber for high-altitude tests or can be moved under an adjacent ambient test bay for atmosphere tests.

Each of the test stations has a 40-in. 550 lb. optical window, which is reportedly flat to 1/10 the wavelength of sodium light, in the floor for viewing the optics below.

The system, designated Photo-Optical Terrain Simulator (POTS) includes a fan array of 8 collimators with interchangeable stationary reticles or image motion simulators. The vertical collimator, with a focal length of 27 ft. and a 36-in. diameter, is said to be the largest in the U.S.

The infinity-focused, high and low-contrast resolution targets produced are the criteria for evaluating performance of aerospace camera system, optical systems, and electronic instruments with optical and photographic outputs. High-contrast resolution targets simulate celestial bodies and low-contrast targets represent terrain.

Diffused light from variac-controlled colt cathode or tungsten lamps passes through the resolution patterns of the collimator reticles to a 40-in. neutral density plane parallel beam splitter. A unique cooling system for the tungsten lamp housing protects the reticles from excessive heat and assures a constant temperature in the collimation system.

Half of the light hitting the lower face of the 600-lb. beam-splitter is transmitted and absorbed in the black walls of the mount or lost beneath the steel structure which acts as a baffle. The remaining light is directed downward toward a 36-in. parabolic mirror weighing 700 lbs. and then reflected upward to the sensor specimen.

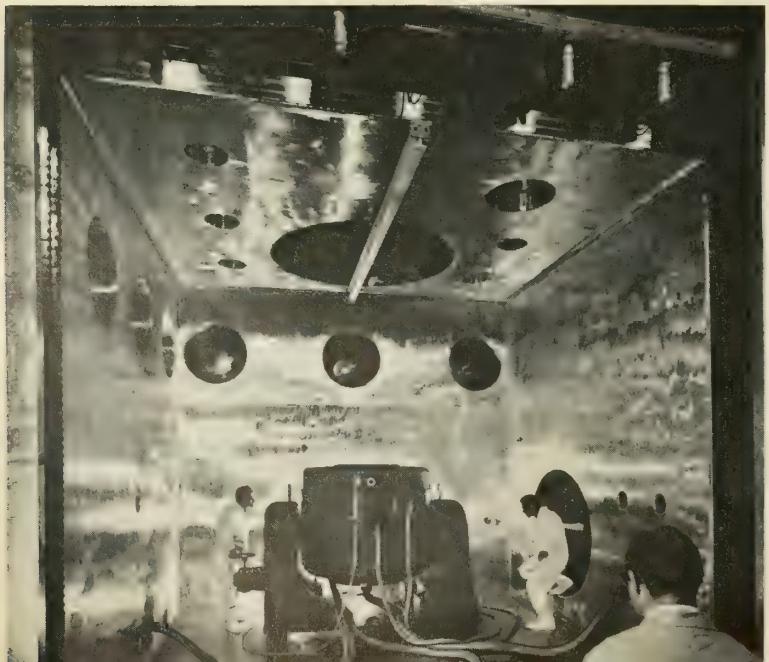
• **Special IMS**—A highly precise Image Motion Simulator (IMS) was specially developed to determine the quality and reliability of image motion compensation correction. Resolution patterns exposed on an endless film belt are driven by a variable speed motor at rates up to 8-in. per sec. to simulate the apparent motion of terrain beneath airborne or space vehicles.

Final check of the off-axis collimators is made with an 80-in. f/8 astronomical telescope to assure infinity focus and strain-free mounting of the optics.

Floated on 30 heavy-duty springs, the 138-ton steel-reinforced concrete mounting isolates the 55-ton space chamber, collimation system and equipment under test from all vibrations with frequency of more than one cycle/sec.

To simulate vehicle launch and hard landings, a 600-lb. capacity Barry shock machine producing up to 200 g's is also available in the laboratory. ■

TECHNICIANS at new Space Environment Laboratory of Fairchild's Defense Products Div. prepare 15-ton vibration exciter for test inside 3000-cu.-ft. high altitude-temperature chamber. Entire 15-ft.-wide wall has been lowered to permit movement of shaker into chamber by rail-mounted, power-operated gantry. Large circular hole in ceiling indicates position of "top hat" dome with 19-ft. clearance.



Du Pont Boosts Hi-Temp Strengths

by John F. Judge

A NEW CONCEPT in dispersion-modified metals developed by the E. I. du Pont de Nemours & Co., Inc., is expected to fill the present void between superalloys and refractory metals in extended high-temperature service.

The strengthening process is essentially colloidal and results from a Du Pont effort to apply chemistry to metallurgy. The chemical technique, which is patented, consists of an extremely uniform dispersion of minute oxide particles in metals and their alloys.

The process will cover a broad range of materials capable of extended service in the 1800°-2400°F range with room-temperature fabricability.

• **On the market** — The first such alloy—designated TD-Nickel—is commercially available in the usual mill forms from the company's metals plant in Baltimore. The Ni-2% Th alloy has excellent stress rupture strength in the 1800°-2400°F range—withstanding greater stresses than the superalloys for times exceeding 300 hours at 1800°F.

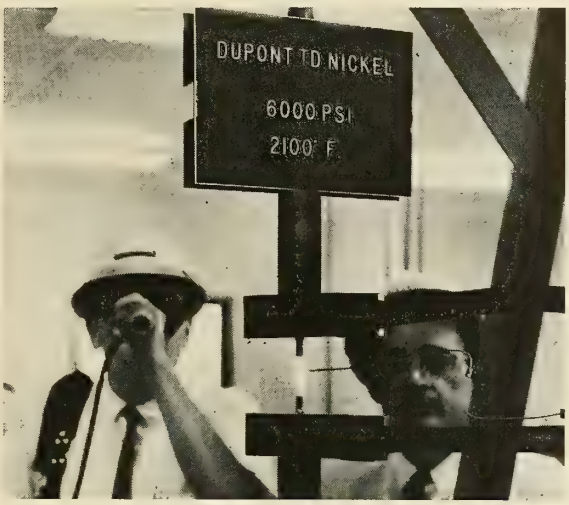
Its stability at high temperature far surpasses that of the superalloys because the thorium precipitate does not melt. The TD-Nickel has been taken to within 50° of its melting point and held for several hours without affecting its strength.

Dr. W. A. Jenkins, technical manager of metal products, explained the strengthening effect by referring to the familar precipitation-hardening technique.

Any pure metal is composed of tiny areas known as grains, joined in random fashion along lines called grain boundaries. When under tension, the atoms within these grains slip past one another and, as these motions are translated to the grains, the metal yields to the stress, stretches and loses strength. Heat speeds this phenomenon.

Metallurgists came up with precipitation-hardening to offset this slippage. It is possible by heat-treatment to obtain extremely small particles between and within the grains. These block intergrain motion and strengthen the metal. Many alloys including the nickel-based superalloys, are strengthened in this manner.

But precipitation-hardening has a basic weakness, says Jenkins. To make a metal structure like this, a strengthener must be found which will dissolve in the base metal at high temperatures. Aging at lower temperatures brings out the hardening component in a special way, and the product is formed.



THE BEST superalloys would fail in this test, say Du Pont scientists. TD-Nickel is priced at $20/lb., but the process is volume-sensitive. Work is progressing in the welding area, and some form of fusion welding should be applicable to the new alloy.

Thus the agent must be soluble in the metal—the first limitation. Then the hardening agents themselves may dissolve at the desired operational temperature, losing strength.

No great improvements have been made through powder metallurgical method, even though years of research have gone into upgrading the technique. Du Pont cracked the problem with a proprietary chemical approach.

With respect to TD-Nickel, the precipitate increases the high-temperature tensile strength of pure nickel by factors of three or four—10,000 psi ultimate at 2400°F. Jenkins says the alloy resists oxidation at high temperatures far better than pure nickel and is almost in a class with the best nickel alloys.

The alloy works just like pure nickel, says Jenkins, and while it work-hardens, the ductility is recovered through heat-treat without strength losses. Its conductivity, both electrical and thermal, is about as good as pure nickel.

• **Other metals** — While the TD-Nickel is the first commercially available alloy, Du Pont found the process applicable to cobalt, copper, iron, aluminum, lead, tungsten, molybdenum and other metals. Oxides have received the most attention as strengthening agents simply because of their potential; the list of candidates besides thorium is long.

Raw material for the alloy is manufactured in a pilot unit at Du Pont's Belle, W.Va., plant. A larger-scale plant is being built at Newport, Del. The TD-Nickel bar is produced at the Metals Plant through powder fabrication techniques.

Dr. W. S. Wartel, technical supervisor at the Metals Center, stresses "fabrication" rather than powder "metallurgy," since the TD Nickel bar is equivalent in every way to a cast-and-wrought product with respect to density and soundness.

The alloy powder is loaded into rubber boots and compacted at 60,000 psi. After sintering in a hydrogen atmosphere, the billet is extruded and room-temperature-drawn to stock dimensions.

The Space-Age metals facility (M/R, May 15, 1961, p. 26) has produced sheet, tubing and wire as fine as 0.002-in.-dia. in the new alloy. The center is a production facility, although it resembles a research area in its cleanliness and layout. Refractory metal mill stock is the main product line, with columbium getting the greatest emphasis. The columbium alloy currently being produced goes directly into re-entry glide vehicle programs.

The center has a unique rolling mill built by Schloeman A.G., Dusseldorf, W. Germany, which can be operated either as a 2-high, 4-high, single or double cluster mill. Its separating force is 5 million lbs., and it rolls either hot or cold—producing 2 in. plate down to 0.002 in. sheet up to 30 in. wide ⌗

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contracts

AIR FORCE

$26,083,000—**General Dynamics Corp.**, San Diego, for development of *Atlas* missiles (4 contracts).

$16,833,192—**Boeing Co.**, Seattle, for work on *Minuteman* missiles.

$11,869,077—**Martin Marietta Corp.**, Baltimore, for work on *Titan* missiles (2 contracts).

$10,807,077—**Martin Marietta Corp.**, Baltimore, for work as integrating contractor at Lowry AFB *Titan* sites.

$7,534,000—**Boeing Co.**, Seattle, for work on *Minuteman* missiles (2 contracts).

$7,344,060—**American Air Filter Co.**, Louisville, for providing proper temperature, humidity, ventilation and air filtration for launch control personnel and electronic equipment of *Minuteman* missile sites at Ellsworth AFB, S.D.

$6,300,000—**Litton Systems, Inc.**, for aerospace vehicles. Work to be done at Woodland Hills, Calif.

$4,732,152—**Mitre Corp.**, Bedford, Mass., for systems engineering and technical development for command and control systems.

$4,490,691—**North American Aviation, Inc.**, Canoga Park, Calif., for work on rocket-engine test stands at Edwards AFB.

$4,460,790—**Martin Marietta Corp.**, Baltimore, for development of *Titan I* missiles.

$4,276,289—**Boeing Co.**, Seattle, for work on *Minuteman* missiles.

$4,035,653—**Aerospace Corp.**, El Segundo, for work on various ballistic missile programs.

$2,789,000—**Martin Marietta Co**, Baltimore, for development of *Titan* surface-to-surface missiles.

$2,276,425 — **North American Aviation, Inc.**, Downey, Calif., for spare parts for *Minuteman* missile guidance and control systems.

$2,080,000—**Litton Systems, Inc.**, Woodland Hills, Calif., for equipment and technical services in support of an integrated flight control system for manned advanced aeronautical aerospace vehicles.

$2,080,000—**General Electric Co.**, Philadelphia, for work on *Titan II* missiles.

$1,830,000—**Douglas Aircraft Co., Inc.**, Santa Monica, Calif., for modification of and provision of launch services for the *Thor* missile.

$1,187,000—**United Aircraft Corp.**, East Hartford, Conn., for research and development for an advanced stellar inertial guidance system (supplemental contract).

$1,172,410—**Avco Corp.**, Wilmington, Mass., for work on nose cones.

$1,150,000—**Lockheed Aircraft Corp.**, Burbank, Calif., for work on space vehicles.

$1,062,000—**Martin Marietta Corp.**, Baltimore, for umbilical installation and testing for *Titan I* missile site activations at Ellsworth AFB, Mountain Home AFB, Larson AFB and Beale AFB.

$480,500—**Union Carbide Chemicals Co.**, New York City, for development of new high-energy, storable liquid rocket propellants.

$172,000—**General Precision Aerospace, Kearfott Div.**, Little Falls, N.J., for building a feasibility model of a star angle comparator and associated support equipment.

ARMY

$6,491,960—**Western Electric Co.**, New York City, for additional research and development on the *Nike-Zeus* antimissile missile system.

$4,358,704—**Bendix Corp.**, for development work on communications satellites, at Towson, Md., and for work on guidance and control components of the *Pershing* surface-to-surface missile at Teterboro, N.J. (2 contracts).

$2,772,316—**Western Electric Co.**, New York, for continued research and development work on *Nike-Zeus* antimissile missile.

$2,000,000—**Martin Co.**, Orlando, for repair parts for the *Pershing* missile system.

$1,194,906—**Ling-Temco-Vought, Inc.**, Dallas, for production of erector-launcher vehicles for the *Sergeant* ground-attack missile.

$1,149,198—**Western Electric Co.**, New York, for *Nike-Hercules* ground equipment. Work to be done at Burlington, N.C.

$1,009,000—**General Electric Co.**, Burlington, Vt., for work in connection with the *Little John* rocket.

NAVY

$36,287,000—**Lockheed Aircraft Corp.**, Sunnyvale, Calif., for work on *Polaris* missiles (2 contracts).

$9,004,533—**Sperry Gyroscope Co.**, Great Neck, N.Y., for continued engineering and production work on submarine navigation equipment for the *Polaris* program.

$5,364,686—**General Electric Co**, Pittsfield, Mass., for fire controls and guidance training equipment for the *Polaris* program.

$3,250,027—**Lockheed Aircraft Corp.**, Sunnyvale, Calif., for work on the *Polaris* missile program.

$3,200,000—**Hercules Powder Co.**, Wilmington, Del., for continued research and development work on solid-rocket propellants.

NASA

$111,000—**Martin Co.'s Electronic Systems and Products Div.**, Baltimore, for fabrication of 10 infrared horizon sensors and associated power supplies for the *Saturn* vehicle.

Swedlow, Inc., Los Angeles, for participation in the *Trailblazer* re-entry research vehicle program (undisclosed amount).

INDUSTRY

$6,000,000—**Textron's Bell Aerosystems Co.**, Buffalo, N.Y., from **Lockheed Missiles and Space Co.**, Sunnyvale, Calif., for follow-on production of the *Agena* liquid rocket engine.

$1,400,000—**Talley Industries**, Mesa, Ariz., from the **Boeing Co.**, Seattle, for devices for *Minuteman* ground support equipment.

$1,100,000—**Moog Servocontroles, Inc.**, East Aurora, N.Y., from **Ling-Temco-Vought, Inc.**, for servovalves to be used in the flight control system of the *Minuteman* missile.

$850,000—**American Machine and Foundry Co., AMF Atomics Div**, New York City, from **Aerojet-General Corp.**, for design and production of remote handling systems for the *NERVA* program.

$300,000—**Hughes Aircraft Co.**, Newport Beach, Calif., from **General Dynamics/Astronautics**, San Diego, for production of transistors for the *Atlas* missile.

$142,000—**Bulova Watch Co., Inc., Industrial and Military Products Div.**, Jackson Heights, N.Y., from the **Orlando Div. of Martin Co**, for warhead triggering devices for *Bullpup* air-to-ground missiles.

$76,000—**Cannon Electric Co.**, Phoenix, from **Boeing Co.**, for electrical umbilical connectors for use on the *Dyna-Soar*.

Thompson Ramo Wooldridge, Inc., TAPCO Div., Cleveland, from **Aerojet-General Corp.**, for fabrication of first-stage *Polaris A-3* propellant rocket nozzle assemblies (undisclosed amount).

North American Aviation's Rocketdyne Div., McGregor, Tex., from the **Columbus Div.**, for development of an advanced solid-propellant booster for the Army's *Redhead-Roadrunner* target missile system.

High-Energy Engine

(Continued from page 12)

ment setup or General Dynamics/Convair's industrial portion of the program.

The subcommittee's report follows public hearings on the *Centaur* program which were held in May. The investigation was initiated to determine why the launch vehicle's development program had fallen so far behind schedule.

Its first test flight was scheduled for June, 1961. After slipping to May, 1962, it was unsuccessful when a structural defect in the *Centaur* caused an explosion. The second launch was slated for October, 1962, but it has now been rescheduled for early next year.

The Subcommittee's major recommendations included:

—NASA should initiate a study to determine whether the *Centaur* program deserves a DX priority—the nation's highest. The subcommittee said it believes that if the program is so important, the priority is necessary. Rep. Karth said the subcommittee feels that the program may need additional funding, and he indicated it would be approved if requested by NASA.

—The Government Accounting Office should be requested to conduct an investigation of the *Centaur* project to determine whether government interests had been protected in contracting. ⌗

Project Pluto

(Continued from page 14)

"A nuclear ramjet powerplant offers the capability of flying around the world. This offers the advantage of being able to strike the enemy from any direction whatsoever. He can no longer fix his defense posture in any one segment. He must look at it from an omnidirectional standpoint.

"It offers the greatest payload of any missile designed. We think of one, two, three, and even five percent for ballistic missiles as useful payload. When you couple the unlimited range, the omnidirectional strike capability with the high payload fraction, you expose a new and different threat to the enemy. Any defense posture that he may have that would be common for any ballistic missile would not suffice for a low-altitude omnidirectional high-speed nuclear ramjet missile."

He told the committee that the missile would have a mechanical guidance system. "There are several contracts with industrial contractors, one with IBM and one with Chance Vought and others, to develop guidance systems or components guidance systems that would predict very accurate delivery of warheads from such a device." ⌗

Defense Contracts Go West

Geographic distribution of prime defense contracts has shifted dramatically since the Korean War from Midwest and Mid-Atlantic states to the West Coast.

A DOD report explains that the trend is largely a result of the move towards more sophisticated missiles and electronics and away from production-line items, and the heavy concentration of RDT&E firms in California. The latter is a factor because "any company which has conducted or managed the research, design, development and test work on a new weapon system—or a major component—and has assembled the engineering talent and experience for this purpose, is obviously in an exceptionally strong position to compete for the follow-on production contracts, and for new development contracts as well. It is logical, then, that production contracts for the newer sophisticated items, which will figure heavily in future procurement, may tend to be placed in areas where RDT&E effort has been centered."

The report, "The Changing Patterns of Defense Procurement," was signed by Deputy Defense Secretary Roswell Gilpatric, who said the recent trend of R&D "foreshadows a continuation of the trends of the past." DOD has launched a study of the R&D trend.

Highlights of the report show that:

During Fiscal 1953, tanks, other vehicles, weapons and ammunition and other kinds of hardware accounted for 50% of the military hard goods. By Fiscal '61, this had dropped to 12.4% of total prime contract awards. Missiles accounted for ½% in '53, 33.6% last year.

In FY '61, 57.9% of all missile awards and 24.9% of all electronics awards were for RDT&E. There has been a strong tendency toward concentration of such contracts in California and the East Coast strip from Boston to Washington.

The states of Michigan, Illinois, Ohio, Indiana and Wisconsin received $2.6 billion in prime contracts last year—a drop of $6.1 billion in eight years. Mountain and Pacific states had 18.6% of prime contracts in 1953; last year this rose to 32.6%.

Research and development contracts accounted for about $6 billion last year. Of this, 41.3% was concentrated in California, 12.2% in New York and 5.8% in Massachusetts. These three plus Washington, Colorado, New Jersey, Pennsylvania, Maryland, Utah, Florida, Ohio and Connecticut accounted for 90% of all R&D contracts.

International News Briefs

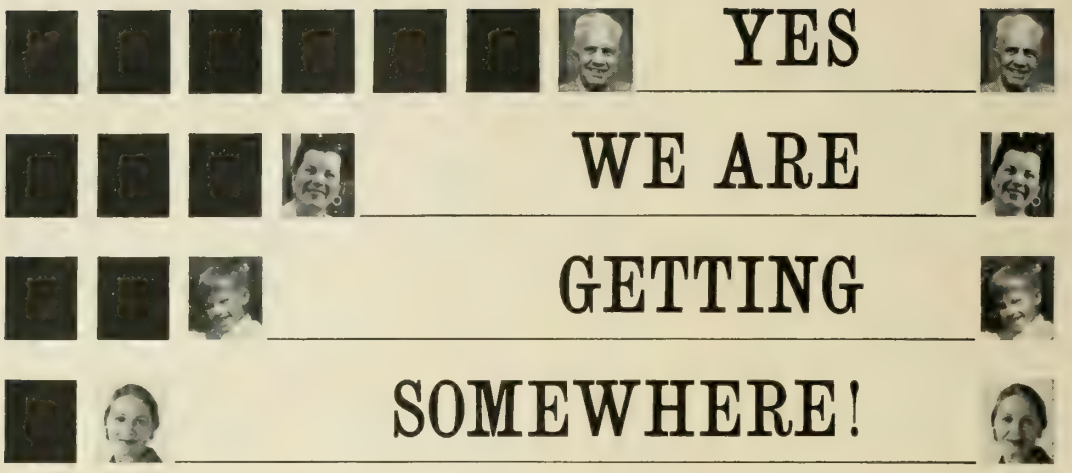
Garrett Manufacturing Limited opened a new plant in Etobicoke, Ontario, to produce equipment for Canadian-U.S. military and commercial aerospace industries. Facilities had previously been spread around several separate locations. . . . *American aerospace exports totaled $377 million during the first quarter of 1962, 23% over the same period last year.* . . . The convention setting up the European Space Research Organization (ESRO) is being forwarded to nine European governments for ratification. It will come into effect after approval by six of the governments. ESRO plans call for an initial $310-million program for launching of 440 sounding rockets, 22 low-orbit satellites, several space probes and some larger scientific satellites. . . . *Atlas Taiwan Corp. has been formed in Formosa to build and operate a commercial explosives plant. The company is a subsidiary of Atlas Chemical Industries, Inc.*

News of Mergers and Acquisitions

Fairchild Camera and Instrument Corp. acquired the Central Electronic Manufacturers Div. of Nuclear Corp. of America, Inc. Central will become a department of Fairchild's Du Mont Electronic Tube Div. . . . *The Budd Co. has entered into an agreement to purchase the Brightwater Paper Co., Adams, Mass.* . . . American Asbestos Textile Corp., Norristown, Pa., will acquire the Meredith, N.H., asbestos textile manufacturing facilities of Keasbey & Mattison Co.

New Industry Facilities

Consolidated Systems Corp. is building a new facility in Pomona, Calif. The company designs, develops and produces electronic, mechanical and optical systems. . . . *Aero Geo Astro Corp. will open a facility in Pasadena, Calif., to develop satellite payload instrumentation. The facility will supply engineering services in support of West Coast space programs and design and develop electronic payload components for satellites.* . . . Sundstrand Aviation-Denver, a Sundstrand Corp. division, is consolidating its test facilities through expansion of its Denver facilities. Improved facilities for the company, which makes aerospace accessory power systems, include an environmental test chamber capable of simulating the vacuum of outer space and a centrifuge. . . . *Motorola's Semiconductor Products Div. is investing over $3 million in additional production facilities at its Phoenix, Ariz., plant. The expansion is being done three years ahead of original plans because of an "unprecedented growth in all product lines."* . . . Shieldtron, Inc., Shielding Div. began construction of a new manufacturing facility in Moorestown, N.J., to make radio frequency interference enclosures.



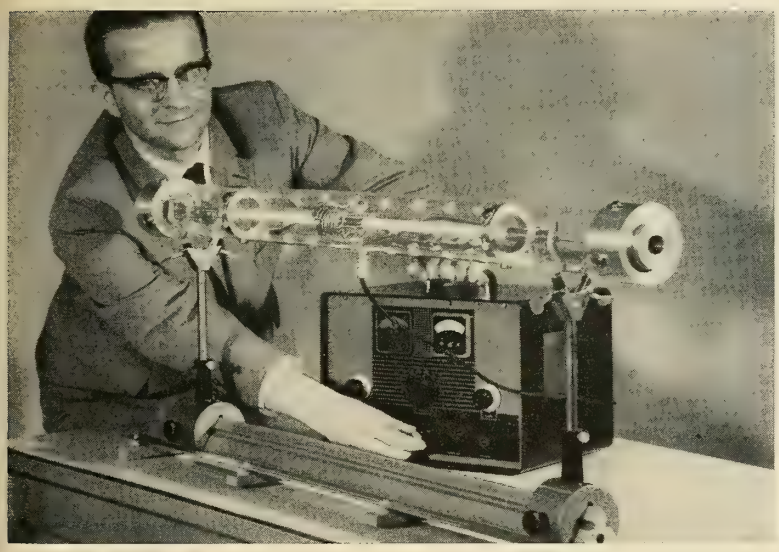
YES WE ARE GETTING SOMEWHERE!

Twenty-five years ago, only 1 in 7 cancer patients was being cured. Fourteen years ago, 1 in 4. Today, 1 in 3 is being saved.

With what science knows about cancer right now, *one in two* could be saved by means of earlier diagnosis and proper treatment. The tragic fact is, however, that this year more than 85,000 Americans – who might have been saved – will die from cancer!

To learn how to guard yourself against cancer . . . the importance of Cancer's Seven Danger Signals and other life-saving facts . . . call your nearest Unit of the American Cancer Society or write to "Cancer" in care of your local post office. More than a million Americans are alive and well today, cured of cancer, because they went to their doctors in time.

AMERICAN CANCER SOCIETY®



New Product of the Week: Rugged Helium-Neon Laser

A HELIUM-NEON LASER warranted for 1000 hours of continuous operation has been introduced by Raytheon Co.'s Special Microwave Devices Operation.

Expected to find wide use in industrial and institutional research laboratories, the model LG-2 employs confocal mirrors spaced 1 meter apart. Output from each end is 1.5 milliwatts. Beam dispersion is 8 minutes of arc.

Other gaseous lasers, recommended for experiments requiring photo-beating, are available on special order. Features include temperature-compensating structures for precise control of change in cavity length.

Circle No. 225 on Subscriber Service Card

Glass-Filled Teflon Fitting Seals

Glass-filled Teflon fitting seals are available from Del Manufacturing Co. Addition of this chemically inert material to the currently stocked copper, aluminum, and nickel seals extends to aluminum 37° flare fittings the performance improvements obtained through use of this concept.

Installed between fitting end and flared tube, the soft gasket absorbs fitting, tube, nut, and ferrule tolerances that might otherwise result in leakage. Similarly, leakage due to scratched fittings, poor tubing finishes, and improper torquing is eliminated. In addition, sensitivity to shock, vibration, and other environmental extremes is reduced.

Circle No. 226 on Subscriber Service Card

Silicone Adhesive Sealant

An all-purpose silicone rubber adhesive-sealant in a squeeze tube that requires no added catalyst, and which adheres to most materials without priming, has been placed on the market by General Electric's Silicone Products Department.

RTV-102 is capable of withstanding temperatures from −75°F to 300°F for extended periods and up to 500°F for shorter time periods. Like all silicone rubbers, the material resists moisture, weathering, and aging effects. A significant feature of the material is its low shrinkage, which assures positive sealing.

Circle No. 227 on Subscriber Service Card

Pulse Discharge Systems

A high-voltage electrical pulse discharge systems is available from Technical Operations, Inc. Operating at voltages in excess of 1,000,000 and discharges times of a few billionths of a second, the systems provide useful research tools for exploding-wire studies, acceleration of particles and plasmas, or generation of temperatures of hundreds of thousands of degrees and pressures in the high-intensity-shock range.

They also provide a reliable source of ultrahigh-intensity pulsed light or X-rays for flash photolysis, radiography, electron-beam studies and other relatively unexplored areas of radiation research.

Circle No. 228 on Subscriber Service Card

Tantalum Foil Capacitors

Mallory Capacitor Co., is marketing the 85°C Type TAF tantalum-foil capacitor in five MIL case sizes, either polar or non-polar, in ratings up to 300 volts.

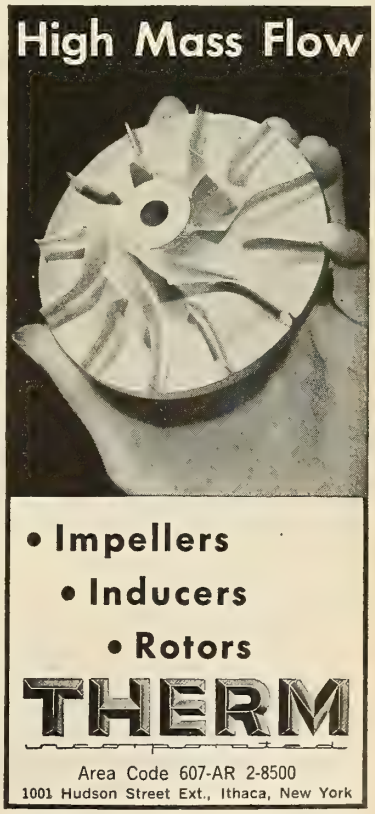
For 125°C applications, Mallory Type TAG tantalum-foil capacitors, either polar on non-polar, will be available in four MIL case sizes at 200 volt ratings. A fifth MIL case size is available in lower ratings.

Circle No. 229 on Subscriber Service Card

Heat-Reflective Tape

Permacel has available a heat-reflective tape (PERMACEL PE 100), for use in protecting materials exposed to high heat.

The tape is made of aluminum foil laminated to glass cloth with a pressure-sensitive silicone adhesive on the glass side. In tests, a black-surface coated steel panel, when exposed to infrared radiation, reached a temperature of



Circle No. 7 on Subscriber Service Card

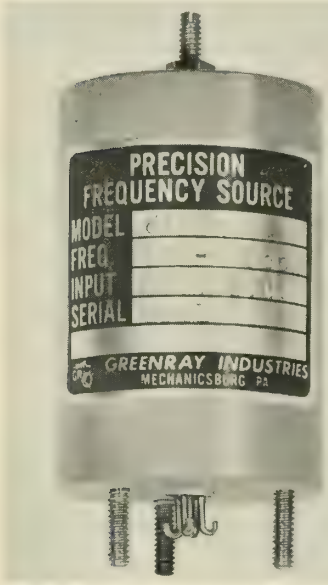
450°F in 12 minutes. The panel was then covered with tape and exposed to the same amount of infrared radiation. The maximum temperature of the panel for the same 12-minute exposure was 190°F.

Circle No. 230 on Subscriber Service Card

Adjustable Frequency Oscillators

Greenray Industries, Inc., has available frequency oscillators (transistorized) which are adjustable to any center frequency specified.

They are available at any specified



center frequency in the frequency range of 400 cps to 10 mc., and can be applied to silicon-controlled rectifiers, power supplies, transmitters, receivers, missile control systems and telemetry systems.

The short-term stability in any given ambient exceeds ±0.5%, long-term frequency stability exceeds ±0.5% over the temperature range of −30°C to +60°C, sine wave, 2.5 V R.M.S. min, external output load: 5000 ohms to 2 megohms.

Circle No. 231 on Subscriber Service Card

Trinistor Controlled-Rectifier

A 7.4-ampere rms forward current Trinistor controlled-rectifier line (JEDEC series 2N1770) for low-power industrial applications is available from the Westinghouse Electric Corp.

Forward blocking voltage ratings are 25 through 400 v and transient peak reverse voltage ratings are 35 through 500 v. Thermal impedance is 2.5°C/watt.

Switching times are typically 10 to 20 microseconds for turnoff and 0.5 to 2.2 microseconds for turn-on. Forward voltage drop is 1.3 volts, and the peak one-cycle surge current rating is 60 amps.

Circle No. 232 on Subscriber Service Card

Automated Resistance Tape Programer

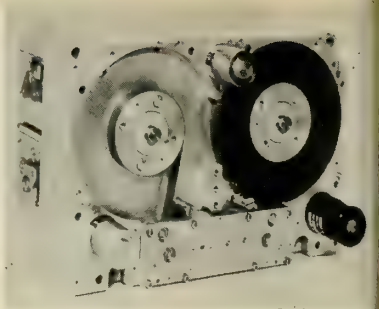
An automated Resistance Tape Programer has been developed by Automation Development. Corp. The Programer, Model 418A, provides automatic programing for power supplies, automatic test equipment, and other instruments and variable resistance of 50 to 300,000 ohms, directly dependent upon the value coded on a punched tape.

Tape feed rate is adjustable from 0.6 in./min. to 10 in./min. Tape information capability is in the 12-bit binary range where each bit is weighted in a standard binary fashion. Input power is 115 volts a-c, 60 CPS, single phase, 100 watts.

Circle No. 233 on Subscriber Service Card

Ruggedized Tape Transport

A ruggedized tape transport which is designed for applications involving



high environment mechanical shocks, eliminates pinch rollers and provides tape-to-head contact is available from Weber Electronics Co.

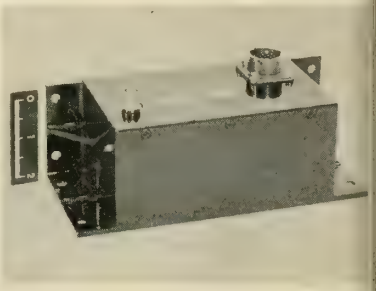
Typical applications are: rocket sleds, missile launch and re-entry, centrifuge, high-performance aircraft, helicopters and shock effects. In relative vibration the unit has 3% flutter with 20 g's, 5-2000 cps applied vibration.

Circle No. 234 on Subscriber Service Card

Advanced Command Receiver

An advanced radio command receiver featuring an isolated ground system and self-contained voltage regulation provision is available from Motorola's Military Electronics Division.

Designated Model MCR-312, the Motorola command receiver is a double-conversion, crystal-controlled, super-



heterodyne FM receiver incorporating three decoder channels (any three of the 20 standard IRIG channels). It operates in the 406-450 mc frequency range.

Circle No. 235 on Subscriber Service Card

Teflon Diaphragms

Diaphragm Industries, Inc. is marketing Teflon-coated diaphragms, which can be flexed in excess of 50 million cycles. High cycle rates, up to 1000 cycles per minute, are possible depending upon the particular application.

These diaphragms are available in sizes from ¼ to 15 in. diameter and over, with strokes from 0.001 to over 3 in.

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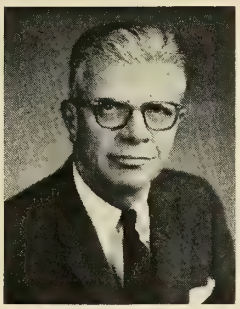
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names in the news


METCALF


KUEHL


PACHYNSKI

George F. Metcalf: Appointed vice president in charge of engineering for Martin Company, Baltimore.

Robert P. Adams: Appointed manager of systems engineering for Scientific Data Systems, Santa Monica, Calif.

Eric Mendel: Appointed vice president and director of Geoscience Instruments Corp., New York, N.Y.

Maj. Gen. Herbert B. Loper (USA, ret.): Joined Washington Associates, Inc., Washington, D.C., as a director and associate.

Frederick V. Martin, Jr.: Appointed manager, Space Programs Development, Fairchild Stratos, Hagerstown, Md. **Robert Reinertsen** appointed manager, Space Business Development.

Joseph M. Walsh: Appointed president of the Instrument Division of Lear Siegler, Inc., Grand Rapids, Mich.

William J. Kuehl: Promoted to general manager of General Electric Co.'s Armament and Control Products Section, Johnson City, N.Y.

J. A. Osborn: Appointed assistant to the manager of advanced development of the Westinghouse electronics division, Baltimore.

Dr. Hubertus Strughold: An M/R contributing editor, named chief scientist of Aerospace Medical Div., Brooks AFB, Tex.

Dr. Robert S. Carlson: Joined Ford Motor Co.'s Aeronutronic Div. as director of Space and Weapons Systems, Newport Beach, Calif.

John R. Moore: Vice president of North American Aviation, Inc., and president of North American's Autonetics Division, designated winner of the Thurlow Navigation Award.

Samuel K. Koffman: President of Rocketdyne Div., North American Aviation, Inc., will receive the Spirit of St. Louis Medal of the American Society of Mechanical Engineers, in Washington, D.C.

Dr. Romney H. Lowry: Chief of bioastronautics for Boeing Co.'s Aero-Space Div., Seattle, elected to the International Academy of Aviation Medicine.

Jack F. Hatton: Chief safety engineer at Lockheed Aircraft Corp., Burbank, Calif., appointed to serve another term on the Industrial Safety Board.

Major Gen. Alvin L. Pachynski (USAF, ret.): Elected to the board of directors of Communicom, a division of Chaskin-Dimmick Corp., Palo Alto, Calif.

Dr. Norman Parker: Named executive vice president-operations of North American Aviation's Autonetics Division, Downey, Calif.

James H. Thompson: Named manager of operations of General Dynamics/Electronics-San Diego. **Ira D. Sykes, Jr.** appointed assistant to the general manager.

Classified

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A Corruption of Security

THE EFFORTS of the Moss subcommittee in working for declassification of the Department of Defense security directive on military space projects should be warmly applauded.

This directive is one of the most stultifying to the proper dissemination of technical information to be issued in some years. It goes far beyond classification of space vehicle launches. The March directive sets up procedures which already are slowing down distribution of important technical information to the industry.

By the insidious method of classifying the classification directive itself, Department of Defense has kept it out of the spotlight of public attention which should be focused on it.

This is not the first time such an underhanded technique has been attempted. We can remember an instance a number of years ago under the previous Administration when the Navy made a similar effort to improperly control contractor handling of information releases. A classified list of Navy projects was attached to the directive and a Secret classification applied to the entire document.

When a trade journal brought the directive to public attention, the White House reversed the Navy and the directive was withdrawn. Whether such a fate is in store for the present directive remains to be seen.

The document in question is DOD Directive S-5200.13. Almost since its issuance, Rep. John E. Moss (D-Calif.) and the staff of his Special Government Information Subcommittee of the House Government Operations Committee have been working for its declassification.

Deletion of a phrase or two is all that is required to declassify the document—removal of references to such darkly secret programs as *Samos* and *Midas*. Yet the directive remains classified some three months after its promulgation.

We question the sincerity of the issuing authority. If the security objectives of the directive are valid ones, they should be able to withstand public scrutiny. It is apparent from industry complaints that the directive goes beyond what has been normal practice, however. We suspect that is a major reason for its classification.

The entire atmosphere surrounding information release has become ominous since issuance of the directive. There is even a "1984" effort to re-write history by literally clipping references to *Samos* and *Midas* from new copies of standard Air Force press kits which have been in circulation for months. This is ridiculous.

Far less amusing is renewed insistence that Air Force be notified in writing by its contractors in advance of any plant visits by newsmen—even when no classified information is involved. This is a gross invasion of contractor and journalistic rights.

"The reason is that we've been asked to closely monitor visits of newsmen," an AF information officer explains. We're certain of that. We recognize police-state thinking when we encounter it.

When a newsman appears unannounced at a contractor's plant, the contractor is required to notify the Air Force information office by telephone. The problem of a newsman telephoning a plant presumably will be solved by wire-tapping!

A meeting of Air Force and contractor representatives was held in Los Angeles recently to discuss some of these problems. The Air Force has denied that the meeting was to seek a way around the DOD space directive. This may be a question of semantics. Certainly, a number of Air Force personnel are unhappy about the DOD document.

Any Air Force effort to speed up clearance of information is most welcome. If the meeting results in procedural changes to effect that, it will have served a useful purpose.

We both understand and regret the reason such a meeting cannot publicly go further. Neither the Air Force nor an industry contractor can openly challenge DOD. The reason was best put by an industry representative who attended the meeting:

"Who's going to argue with DOD? This is $4 billion a year in business."

WE HAVE NO QUARREL with legitimate security. But we most definitely take a stand against unnecessary interference with normal industry information practices. It is particularly lamentable when a false security screen is used to hide the harassment.

Why do we feel so strongly about this? We would like to quote Dr. Theodore W. Van der Nuel, chairman of Garrett Corp.'s Research Board:

"Many times our engineers, reading through technical publications, will find the story of a new development that fits right into a product we are working on. This saves us countless hours of time and development costs, and brings the product to the presentation stage faster and more economically."

Rapid dissemination of technical information can save the country both time and money. It is not inconceivable it could even save the country.

William J. Coughlin



COMMUNICATION

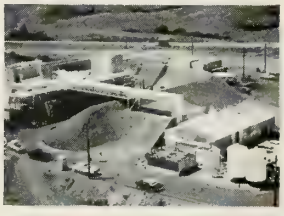
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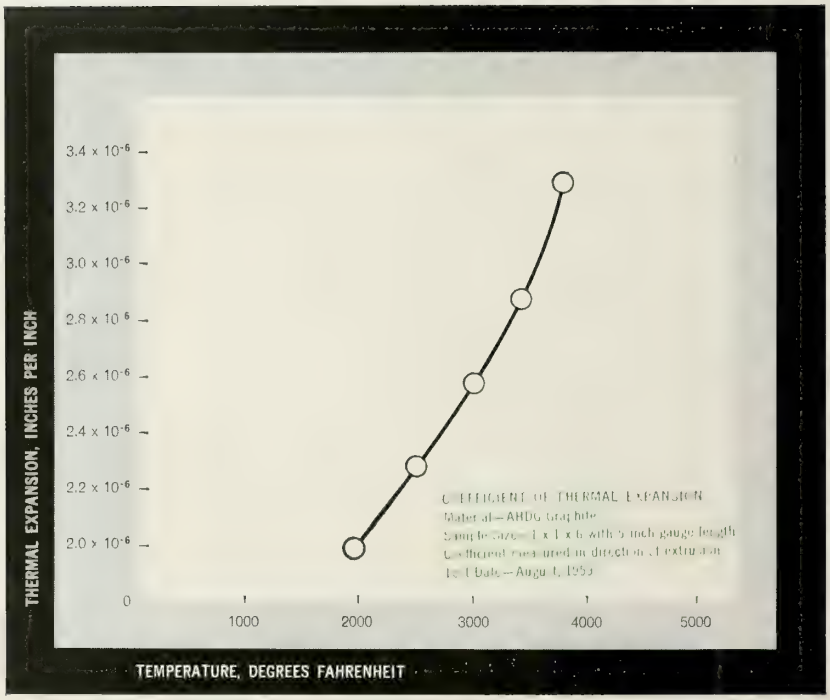


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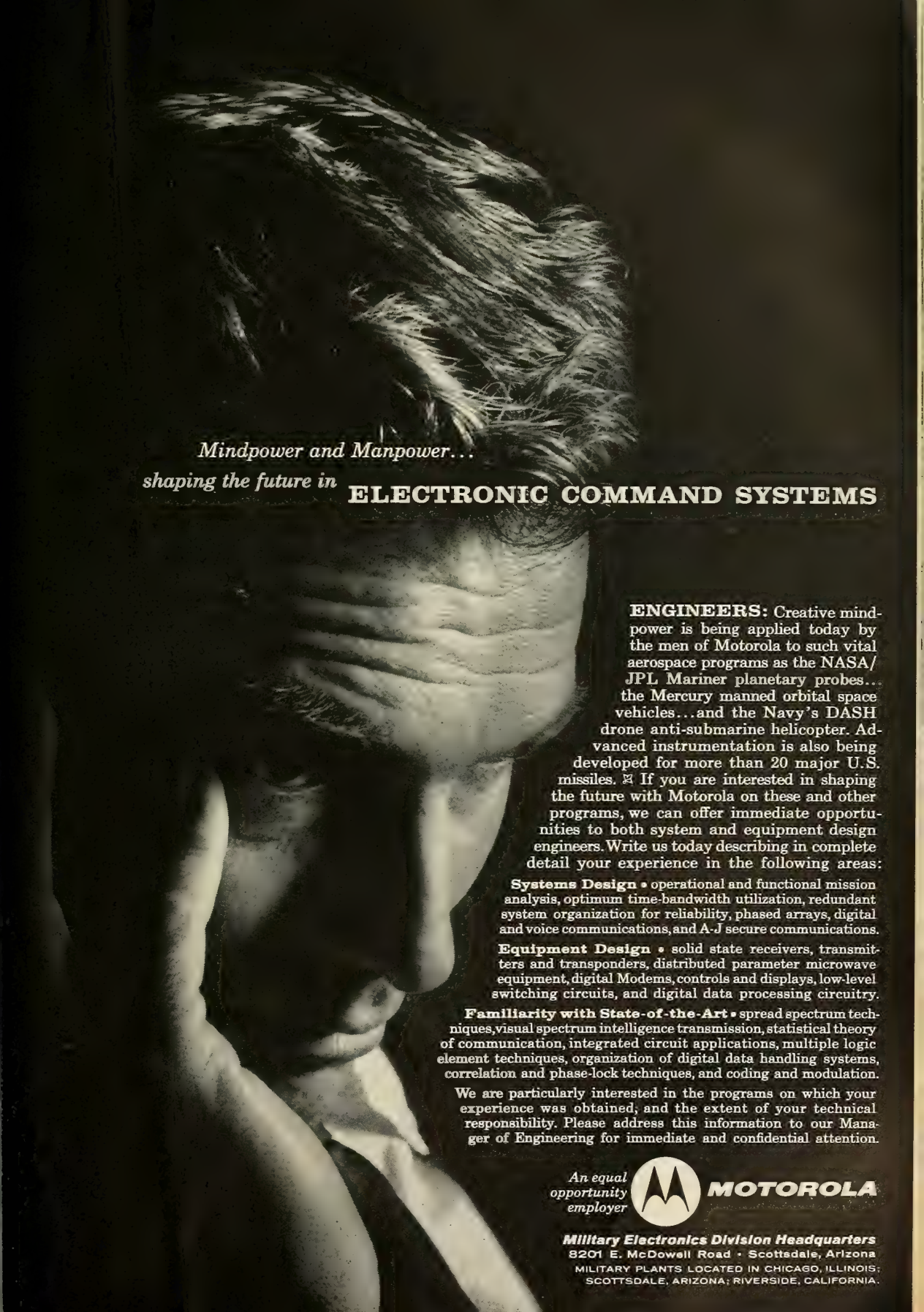
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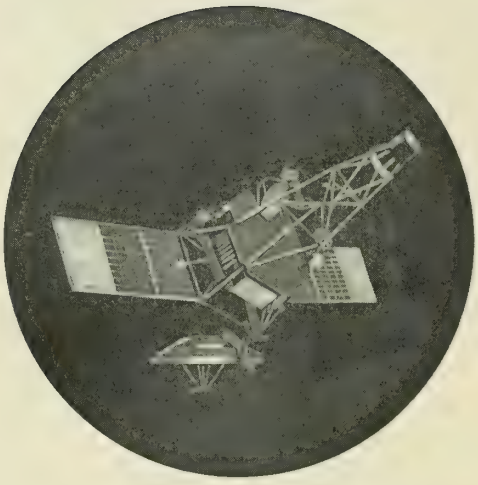
We are particularly interested in the programs on which your experience was obtained, and the extent of your technical responsibility. Please address this information to our Manager of Engineering for immediate and confidential attention.

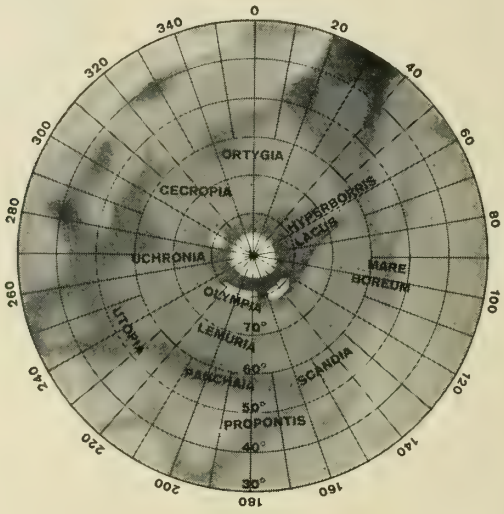
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NASA's PROJECT MARINER / 90 DAYS TO VENUS . . . 200 TO MARS

Project Mariner is NASA's first step to explore Venus and Mars.

The first flight to Venus will take approximately 90 days, to Mars between six and seven months. Initially, the journeys will yield basic information on interplanetary radiation and on the atmosphere and surface temperatures of our neighboring planets.

More sophisticated equipment and powerful boosters will help Mariner provide an increasing body of knowledge in subsequent flights. Some vehicles will send back photographs as they orbit the planets . . . others will carry landing capsules whose instruments can detect the existence of life forms and transmit information about them to Earth.

The ultimate objective of these flights is to learn as much about Mars and Venus as we know about Earth. The Mariner program will unlock secrets of nature once thought to lie outside man's grasp . . . secrets of extraterrestrial life, of the origin of the solar system and the sun itself, and of the universe beyond. The efforts of NASA will not only yield a multitude of scientific discoveries, but will breed a whole new generation of scientists.

SEND JUST ONE RESUME TO NASA . . . it will be reproduced and distributed to all appropriate NASA facilities for consideration. Exceptional career opportunities exist in these locales: Washington, D.C. area; Mountain View and Edwards, Calif.; Hampton and Wallops Island, Va.; Cleveland, Ohio; Huntsville, Ala.; Cape Canaveral, Fla.; and Houston, Texas.

Write to: Director, Professional Staffing, Dept. 501, NASA Headquarters, Washington 25, D.C.

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THE WEEKLY OF SPACE SYSTEMS ENGINEERING

missiles and rockets

Volume 11, Number 2 July 9, 1962

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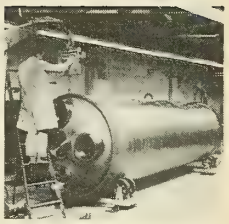
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THE COVER

A technician at Lamtex Industries conducts a weight test on a Minuteman-type glass motor case as part of quality control procedure. Aerospace needs are taking a major share of the filament-wound market. *See p. 24.*

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†U.S. Reg. Pdg.

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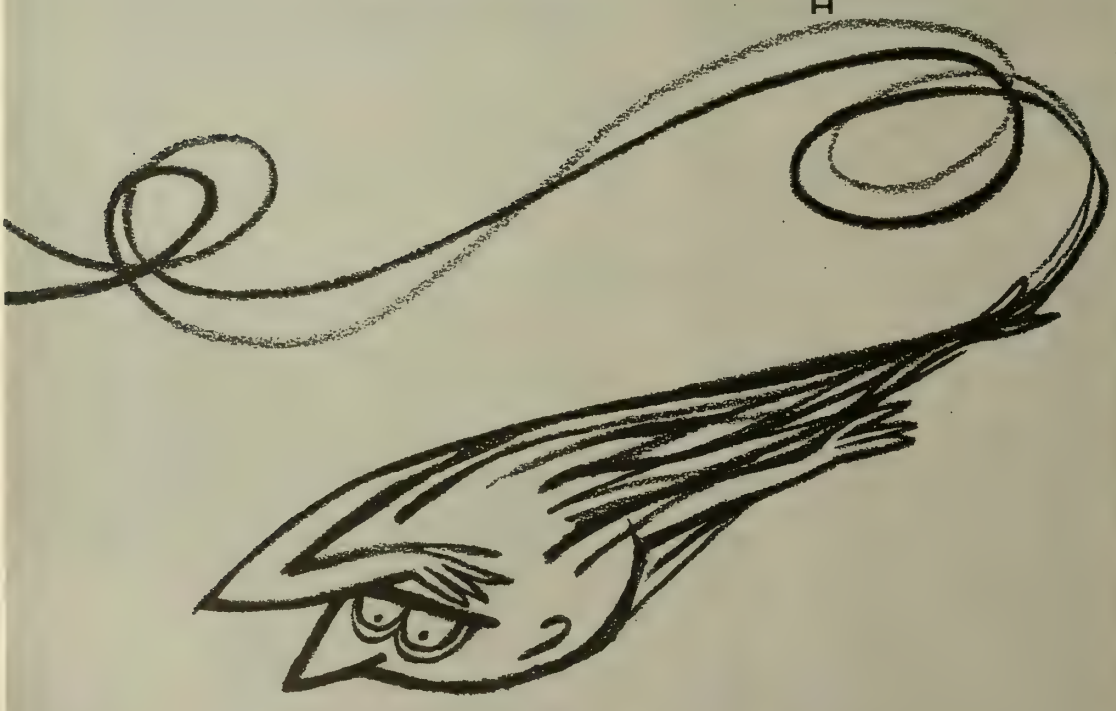
This is a satellite seeking re-entry . . .

Some men are satellites. There is a predictable period to their travels through the rocket motor industry. Sometimes sunseeking, occasionally mildly eccentric, they find security in returning to the same old paths. ■ They will not find entry at UTC. ■ United Technology Corporation has an increasing number of positions open for scientists consciously seeking new paths. Important and challenging studies underway include multimegapound, segmented, solid-propellant boosters; hybrid engines; ablation-cooled thrust chambers, filament-wound fiberglass motor casings. Scientific staff members are preeminent in American rocketry. UTC is solidly backed by the tremendous resources of its parent organization, United Aircraft Corporation. The company's assets include a 30-acre Research and Engineering Center, and a 5000-acre Development Center. ■ Satellite types won't rise to UTC's invitation. Those scientists who do will come to UTC to help create some of America's best rocket motors. ■ An Equal Opportunity Employer.

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letters

On 'Definable Need'

To the Editor:

Re page 13 of your June 25 issue—if Dr. Harold Brown, Director of Defense Research and Engineering, actually told the Senate Space Committee that there is "no definable military need" at this time for manned space vehicles, and expressed *doubt* that manned space vehicles will ever have a military use, he has really caused Khrushchev to chuckle in his vodka.

Didn't someone say similar things about the Wright brothers' airplane? And Goddard's rockets?

John M. Schweizer, Jr.
Brig. Gen. USAF (Ret.)
Assistant to President
Western Region
Bell Aerosystems Co.
Los Angeles

ARS Finances

To the Editor:

Your editorial encouraging open discussion of the proposed ARS-IAS merger ("A Member of the Wedding," M/R, June 25, p. 66) is most welcome. We hope there will be a good deal of discussion now that the Principles of Consolidation have been distributed.

Permit me to object, however, to one remark in your editoral implying that the ARS financial position is questionable. You're not the only one who has made such an inference, and apparently we on the ARS-IAS Consolidation Working Groups have been somewhat at fault for not stating clearly the condition of ARS finances. At any rate, I welcome this opportunity to clarify the matter.

ARS is not only financially solvent but has never been stronger financially in its 32-year history. Merger or no, in 1963 ARS will be even stronger financially than it is this year and will, at the same time, provide more services to members than ever before. (For example, the AIAA Journal "D" described in the Principles of Consolidation document — the monthly "letters" Journal—is an ARS publication which will be sent to all ARS graded members starting in October of this year, with the help of a NASA contract. AIAA will benefit from this ARS-initiated service.)

As a longtime member of ARS yourself, I'm sure you're familiar with the growth of ARS services; for the record, however, I present here a simple tabulation covering how much the Society has spent on its members in the last nine years:

	$ Spent	Members (Beg. of Yr.)	$/Member
'54	60.000	2500	24
'55	137,000	3000	46
'56	228,000	3500	65
'57	465,000	5000	93
'58	613,000	7500	82
'59	905,000	11,500	79
'60	929,000	13,750	68
'61	1,241,000	17,500	71
'62	(pred.) 1,270,000	20,500	62
*'63	(pred.) 1,714,000	23,500	73

*** If no merger takes place.**

As a non-profit organization, the ARS Board has never felt that the accumulation of large financial holdings was desirable—although I'm sure you will concede that this could have been done by simply holding down expenditures on member services. Your magazine would have been rightly critical of us if we had done this.

The reason that ARS shows a small liability is that three years ago, on the recommendation of the Society's auditing firm, Ernst & Ernst, we decided to classify members' dues as "deferred income" (in other words, we enter a member's $20 dues as income at the rate of $1.67 per month rather than enter the whole $20 on receipt). This is an accepted bookkeeping practice, but one which we had not had in effect prior to that time. Deferred membership dues income now amounts to some $230,000. The fact is that if ARS were to liquidate today, it would have to decide which charity should get approximately $130,000 in net assets.

On the basis of the first six months' performance in 1962, ARS continues to be very healthy in the three income areas most vital to a Society's financial well-being: membership, advertising and technical displays.

Membership income in the first six months is 32% over the income from the same period last year. Advertising income is up 8% over last year (although most magazines in the aerospace field are *down* in advertising income). As far as technical displays are concerned, income is expected to at least equal that from last year's Space Flight Report to the Nation, while costs will be considerably less. (The AIA ruling on exhibits has not materially affected ARS—because the AIA companies recognize the ARS exhibit as a technical display with an important function.)

I hope as many ARS and IAS members as possible will attend the forum on ARS-IAS merger which will be held at the Pick-Carter Hotel in Cleveland on the afternoon of Wednesday, July 18, during the ARS Lunar Missions Meeting. We will have full financial figures there and will be glad to answer any questions.

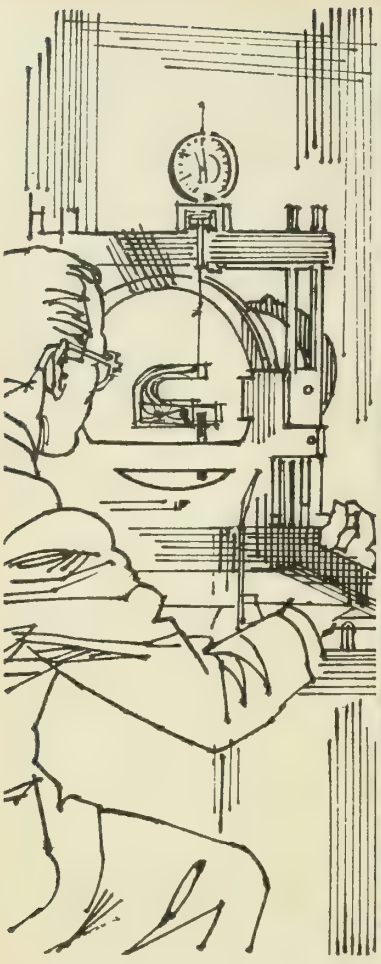
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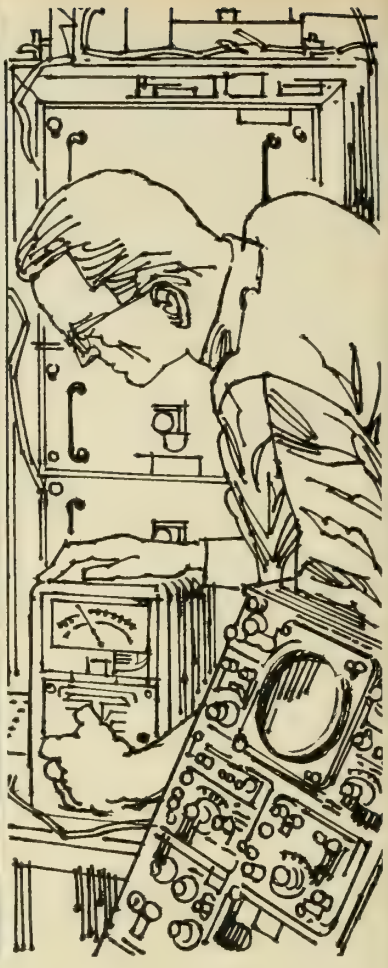
To the Editor:

Personnel of the Aeronautical Chart and Information Center read your report, "U.S. Steps Up Planning for Moon" (M/R, June 18, p. 22) with special interest because of the work being accomplished here in connection with the Moon. Congratulations on a report of events which are significant to all who watch U.S. steps in space exploration.

Joe W. Pickett, Lt. Col., USAF
Director of Operations
Aeronautical Chart and
Information Center, USAF
St. Louis







Saturn openings at Boeing for Engineers and Scientists

Boeing has been awarded primary developmental, building and test responsibility for the Saturn S-IC advanced first stage booster. The Aero-Space Division's newly-formed Saturn Booster Branch has a number of immediate, long-range openings offering professional challenge, rapid advancement and ground-floor opportunities to graduate engineers and scientists.

This new Saturn program is expanding rapidly, providing unique advancement advantages to properly qualified Structural Design, Electronics/Electrical, Propulsion, Aeronautical, Cryogenics, Systems Test, Thermodynamics, Mechanical Design, Industrial and Manufacturing Engineers, as well as to Physicists and Mathematicians. Assignments are immediately available in many areas of activity, including Research and Development, Design, Manufacturing and Test. Salaries are commensurate with all levels of education and experience. Minimum requirements are a B.S. degree in any applicable scientific discipline. Boeing pays liberal travel and moving allowances to newly-hired engineers.



City Park—New Orleans

Assignments are in New Orleans as well as in Huntsville, Alabama. Positions with Saturn and with other expanding missile and space programs at Boeing — including the solid-fuel Minuteman ICBM and Dyna-Soar boost-glide vehicle — are also available at Seattle, Cape Canaveral and Vandenberg AFB, California.

Send your resume, today, to Mr. R. R. Gregg, The Boeing Company, P. O. Box 1680-MRV, Huntsville, Alabama. Boeing is an equal opportunity employer.

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The Countdown

WASHINGTON

Retrieval of Samos Packages

Little was said about it at the time, but reason for the switch from C-119's to C-130's in the Air Force's mid-air retrieval force in the Pacific was to provide a greater capability for snagging re-entering *Samos* film packages.

NASA Will Stick with Six

Contrary to recent newspaper reports, there are no NASA plans for a seven-orbit *MA-8* flight. NASA Administrator James E. Webb has approved only a six-orbit mission. Office of Manned Space Flight officials expect to stick to it.

Mars Shot Due This Summer

First *Mariner* flight to the vicinity of Mars now is scheduled for late July or early August. Second shot is set for September.

Long-Range Atlas Shot Coming Up

Air Force is set to fire an *Atlas D* from Vandenberg AFB to the Philippine Sea this week in a "routine" long-range training exercise. It will be fired by a SAC training crew. The launch is the longest training flight ever carried out over the Pacific.

Army-AF Squabble over Pershing

Army officials are upset over what they believe is an Air Force attempt to grab operational control of *Pershing*. Specifically, they are concerned about a quotation attributed to Maj. Gen. H. R. Spicer, commander of Europe's 17th Air Force, that *"Pershing* would add to the capabilities of tactical air forces and would permit us to reach targets within its range, of which there are quite a few." The Army points out that *Pershing* is a tactical weapon for the field army commander.

AF Control of Hawk and Hercules

Army officers also are unhappy with Air Force control of Army *Hawk* and *Hercules* units in Europe. Firing orders must come from an AF general at USAFE level. Army says this leaves the field commander for whom the missiles were designed without a quick-reaction capability for defending himself.

Next ANNA Launch Date Set

Next attempt to launch the *ANNA* geodetic satellite with a *Thor-Able* booster is planned for late this summer. After its easterly launch, *ANNA* is to be turned 40 degrees to the north into a 600-n.m. orbit. After three months of worldwide data-gathering, the information will be synthesized in a series of international scientific meetings.

INDUSTRY

New Tracking Facility for PMR

A new tracking and range safety facility for Pacific Missile Range will be activated this September at Pt. Pillar, Calif., some 15 mi. south of San Francisco. Equipment to be installed includes FPS-16 tracking radar, automatic gimballed antenna vectoring equipment (AGAVE), two mobile telemetry vans and a command control-destruct system van.

NAA to Pass Wartime Peak

North American Aviation, with corporate employment now at 90,000 expects to pass its peak wartime employment figure of 93,000 within the next 90 days. Rocketdyne Division has grown from 11,000 to 13,000 employes within the past year. Employment at the solid rocket plant at McGregor, Tex., is expected to provide the final spurt with an increase from 700 to 1000.

Military Astronauts at Edwards AFB

Seven Air Force pilots and one Navy flier now are training at Edwards AFB, Calif., for future space missions and projects. The seven-month course, second to be given at the desert base, is the first for potential operational personnel. Earlier course was a pilot program for instructional methods and material and to provide an academic staff for the present course.

Mobile Army Labs for Measurement

Army contractors may be provided with secondary measurement standards by roving mobile labs now under consideration by the Army Ordnance Missile Command. The Army says the vans, calibrated by the AOMC calibration center, would help insure accuracy of industry test and manufacturing equipment.

Freight Trains vs. Space Vehicles

Lear Siegler Corp. is carrying out a study for the Air Force to determine whether AF and the Southern Pacific RR can reach an agreement on scheduling of freight trains through Vandenberg AFB. Problem of unscheduled trains interfering with missile launches is expected to increase as the number of firings increases. Tracks may have to be moved.

Hughes Pushing Lasers Abroad

Hughes Aircraft has started a drive to sell lasers in the United Kingdom. The machines are selling for $850 each, with power supply equipment costing an additional $2650. Marketing targets are government departments, electronic firms, universities and industrial research teams.

INTERNATIONAL

British D.C. Signal Generator

G.E. Bradley Ltd. (Electrical House, Neasden Lane, London, N.W. 10) this week is demonstrating what it claims to be the only d-c signal generator in existence. The generator is said to provide an accurate and highly stable voltage or current source for development, production, testing and servicing of electronic equipment.

De Havilland Engine Co. Disappearing

Britain's familiar de Havilland Engine Co. will cease to trade under that name at the end of this month, and its activities will be carried on by Bristol Siddeley Engines Ltd. This completes the Bristol Siddeley reorganization which followed its acquisition of de Havilland Engine and Blackburn Engines Ltd. in November, 1961.



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The Missile/Space Week

Over 1200 at Michoud

A total of 1239 technical, administrative and support personnel are now employed at the NASA Marshall Space Flight Center Michoud Operations, where preparations are being made for the manufacture of *Saturn* rocket stages.

A breakdown, by organization, of personnel employed at Michoud:

Michoud Operations—(the MSFC element)—presently employed, 57; technical, 40; administrative, 17.

Chrysler Corporation's Space Division (*Saturn S-1* stage contractor)—presently employed, 592; technical, 217; administrative, 375.

The Boeing Company, *Saturn* Branch, Aero-Space Division (*Saturn S-1C* stage contractor)—presently employed, 226; technical, 79; administrative, 147.

Mason-Rust (support services contractor)—presently employed, 364; technical, 22; administrative, 111; guard, transportation and custodial, 231.

A peak employment of some 7000 technical and non-technical personnel is expected to be reached at Michoud by July 1, 1963. Based on present planning, NASA will employ 150, Chrysler 2700, Boeing 3600, and Mason-Rust 590.

Shots of the Week

An Air Force crew successfully fired a Boeing *Minuteman* ICBM from Cape Canaveral on June 29—marking the first time that an all-Air Force team has conducted a test launching of the solid-fuel missile.

Twenty members of the 6555th Aerospace Wing launched the *Minuteman* from its underground silo on a 2700-mile flight down the Atlantic Missile range. It was the eleventh success in 13 underground launchings.

In other shots:

• A land-firing of a Lockheed *Polaris* containing major components of the advanced, 2500-mile *A-3* was successfully conducted June 29 from Cape Canaveral. Carrying a new, lightweight guidance system and an improved nose cone, the missile achieved all its test objectives.

• An air-launched Douglas *Skybolt* missile failed to receive an ignition signal after it was dropped from a B-52 over Cape Canaveral June 29. It fell into the ocean several miles offshore. It was the second test-launch of the *Skybolt*. The first, on April 19, was considered successful even though the second stage failed to ignite.

• An automatic sequencer shut off the engines of an AF Martin *Titan II* missile shortly after ignition when the system detected an incipient failure. The aborted firing, at Cape Canaveral on June 27, apparently caused no damage to the storable-fueled ICBM.

• A high-speed North American *X-15* flight through the atmosphere below 100,000 ft. on June 29 subjected the research plane to air friction temperatures of 1000°F in a test to reveal the craft's "hot spots". Covered with more than 400 heat sensors, the *X-15*, piloted by John McKay, landed unscathed—even though the high temperatures turned the leading edges of the plane bright red.

• The Soviet Union successfully launched the sixth in its current series of *Cosmos* satellites June 30. *Cosmos VI*, according to a Tass announcement, is orbiting the Earth every 90.6 minutes with an apogee of 250 miles and a perigee of 126 miles with all systems operating normally.

High-Altitude Test Set

The third U.S. high-altitude nuclear test was to have been fired July 4 or 5, the AEC announced last week. Boosted by a *Thor*, the nuclear device was to be detonated at an altitude of "hundreds of kilometers".

It was the third, and largest, device scheduled for test during the current series. The first two shots failed when the *Thor* booster had to be destroyed before it reached detonation altitude—once because of a failure in the tracking system and the second time due to excessive heating of the base section of the missile caused by special instrument packages on the outside skin of the missile.

History in the Re-Making

The U.S. Information Agency is currently engaging in a strange type of reverse propaganda—destroying some 10,000 copies of a pamphlet on U.S. space achievements.

Caught in the embarrassing position of being one DOD directive behind, USIA discovered that the pam-

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phlet, already distributed to U.S. embassies overseas, contained descriptions and pictures of the not-officially-existent *Samos* and *Midas* satellites.

Entitled "U.S. Satellites—the First 50", the pamphlet was printed for USIA in Manila for overseas distribution. When the references to *Samos* and *Midas* were discovered, it was ordered destroyed.

Although only a few copies were distributed to embassies in non-English-speaking countries, USIA has authorized the use of the pamphlet in translation—PROVIDED the references to *Samos* and *Midas* are left out.

NASA Elevates Zimmerman

Charles H. Zimmerman, veteran of 33 years in government and private industry in aeronautical work, has been appointed Director of Aeronautical Research in NASA's Office of Advanced Research and Technology.

Zimmerman, who has been associate chief of the aerospace mechanics division of NASA's Langley Research Center, Hampton, Va., since August, 1959, succeeds John Stack, who retired from the post last month.

Stratoscope II Fails

A 77-story-high balloon carrying a simulated telescopic payload failed July 3 to achieve its objectives in what was to have been its final test launching.

The 651-ft.-high *Stratoscope II* balloon—designed to carry a telescope with a 36-in. lens to an altitude of 80,000 ft. to photograph the stars and the planets—not only failed to achieve the desired altitude but also ejected the dummy payload prematurely.

One more test launch will have to be made, project officials said. *Stratoscope II* is sponsored by NASA, the National Science Foundation and the Office of Naval Research.

MIT Hit by Strike

The MIT Employe's Union—composed of machinists, plumbers, stock clerks, janitors and other workers—struck last week when negotiations for a new contract broke down.

Also affected by the walk-out were the MIT-operated Lincoln and Instrumentation Laboratories. In addition, the decision of security guards at Lincoln lab to honor the striking union's picket lines delayed operations at the AF's Hanscom Field Electronic Systems Command.

NEW

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NASA Picks Lunar-Orbit Route

Administrator Webb makes choice on basis of Holmes recommendation; major advantages cited

by Hal Taylor

NASA HAS CONCLUDED its systems engineering review of Project *Apollo* with a decision in favor of lunar-orbit rendezvous for the first manned lunar-landing mission.

The decision confirms a MISSILES AND ROCKETS exclusive report (M/R, June 11, p. 12).

A space agency announcement of the decision was made late last week. It will have five immediate ramifications on the U.S. space program:

1. The space agency in the next few weeks will ask industry for proposals leading to development of a 15-ton two-man lunar-landing vehicle. This will replace the lunar propulsion module under the original concept of the *Apollo* spacecraft.

2. The giant *Nova* superbooster has been relegated to the role of a cargo carrier in the supply of a manned lunar-landing base and the booster for long manned interplanetary flights. NASA, however, will select this month two contractors to perform feasibility and design studies of the *Nova* configuration.

3. The chances of using large solid motors for the first stage of *Nova* are immeasurably increased. The longer timetable for *Nova* development could give large solid-propulsion manufacturers the time needed to catch up with the already-developed large liquid engines which NASA now plans to use.

4. The total cost of the civilian space program will be reduced by 10%. Not only will the lunar-landing vehicle be far less expensive than the lunar propulsion module, but a lunar-orbit rendezvous mission will require only one *Advanced Saturn* launch vehicle.

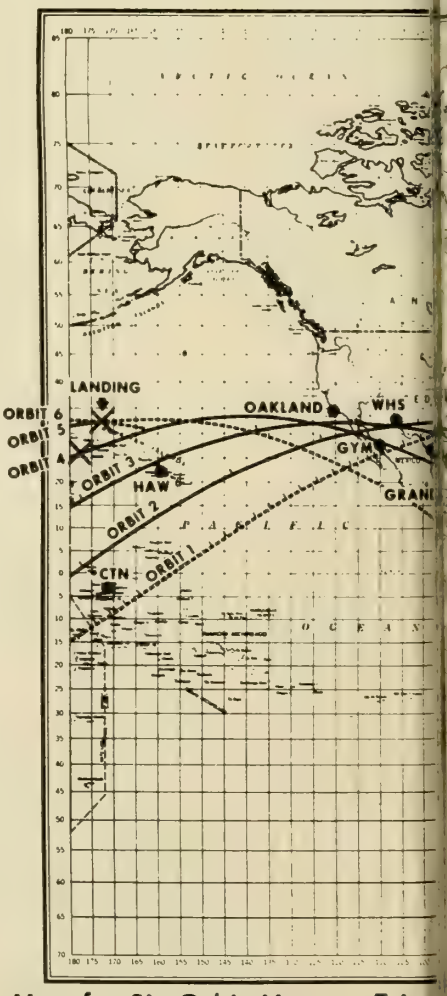
5. A 1967-68 target date for the first manned lunar-landing is entirely feasible, with the latter year more likely.

• **Debate resolved** — The decision selecting lunar-orbit rendezvous was made by NASA Administrator James E. Webb. It followed long months during which the space agency in its official pronouncements declared that Earth-orbital rendezvous was the preferred method of achieving the manned lunar landing. More recently, space agency officials have said that this was only a "temporary" decision.

Webb's decision was based on a recommendation of D. Brainerd Holmes, director of the Office of Manned Space Flight, following a system engineering study of the total requirements of Project *Apollo*.

Lunar-orbit rendezvous received most of its early support from NASA's Manned Spacecraft Center. In opposition was the Marshall Space Flight Center, which preferred Earth-orbital rendezvous technique using two *Advanced Saturn* launch vehicles.

Besides the money- and time-saving factors, the lunar-orbit decision will sharply reduce the size of the *Apollo* spacecraft. The lunar-landing vehicle will weigh two-thirds less than the lunar propulsion module which would have had to weigh about 100,000 lbs. to



Map for Six-Orbit Mercury Trips

NEWLY RELEASED NASA chart shows planned

Rocketdyne Wins $311 Million in Engine Awards

NASA has announced four new contracts with the Rocketdyne Division of North American Aviation, Inc. for a total of $311 million.

The contracts provide for research, development and procurement of liquid oxygen-kerosene F-1 engine, the liquid oxygen-liquid hydrogen J-2 engine, and the H-1 engine.

A breakdown of the four contracts:

• *Research and development on the F-1 engine from September, 1962, to the end of 1966. Total cost, $125 million. Letter contract signed for $1 million.*

• *Production of 55 F-1 engines and supporting equipment with delivery between July, 1963, and August, 1965. Total cost, $124 million. Letter contract for $3.4 million signed to cover early effort in July-September, 1962 period.*

• *Production of 59 J-2 engines and supporting equipment and services between July, 1963, and August, 1965. Total cost, $40 million. A letter contract for $1.7 million has been signed to cover expenses during the July-September, 1962, period.*

• *A total of $22 million for fabrication and delivery of 114 H-1 engines.*

lower the spacecraft to the lunar surface. The lunar-landing "bug" will weigh 30,000 lbs., according to NASA estimates.

Other major advantages of the lunar orbit method include:

—The nominally 50-100-mile-high lunar orbit offers good stability. Because of the low rate of revolution rate of the Moon, the amount of drift of the lunar lander out of the rendezvous plane is small for short periods and presents no steep-ascent trajectory difficulties.

The speed at which the rendezvous must be made is sharply reduced from the 25,000 fps of Earth-orbital rendezvous to 5000 fps of lunar-orbit rendezvous. This reduces the errors associated with launching and the actual rendezvous hookup.

—There are no atmospheric hindrances to launching or rendezvous, as there are in Earth-orbital operations.

—The chances for vehicle reliability are immeasurably improved because the launch vehicle, and increased chances orbit rendezvous will have far fewer stages than the 10 required by Earth-orbit rendezvous.

The feasibility of the lunar-orbit rendezvous was first proposed by Dr. John C. Houbolt of the Langley Research Center.

Dr. Houbolt, reporting the results of detailed NASA studies of the mission, declared that it offers the advantages of reduced Earth-escape weight, use of only a single moderate-sized launch vehicle, and increased chances of a safe landing on the lunar surface.

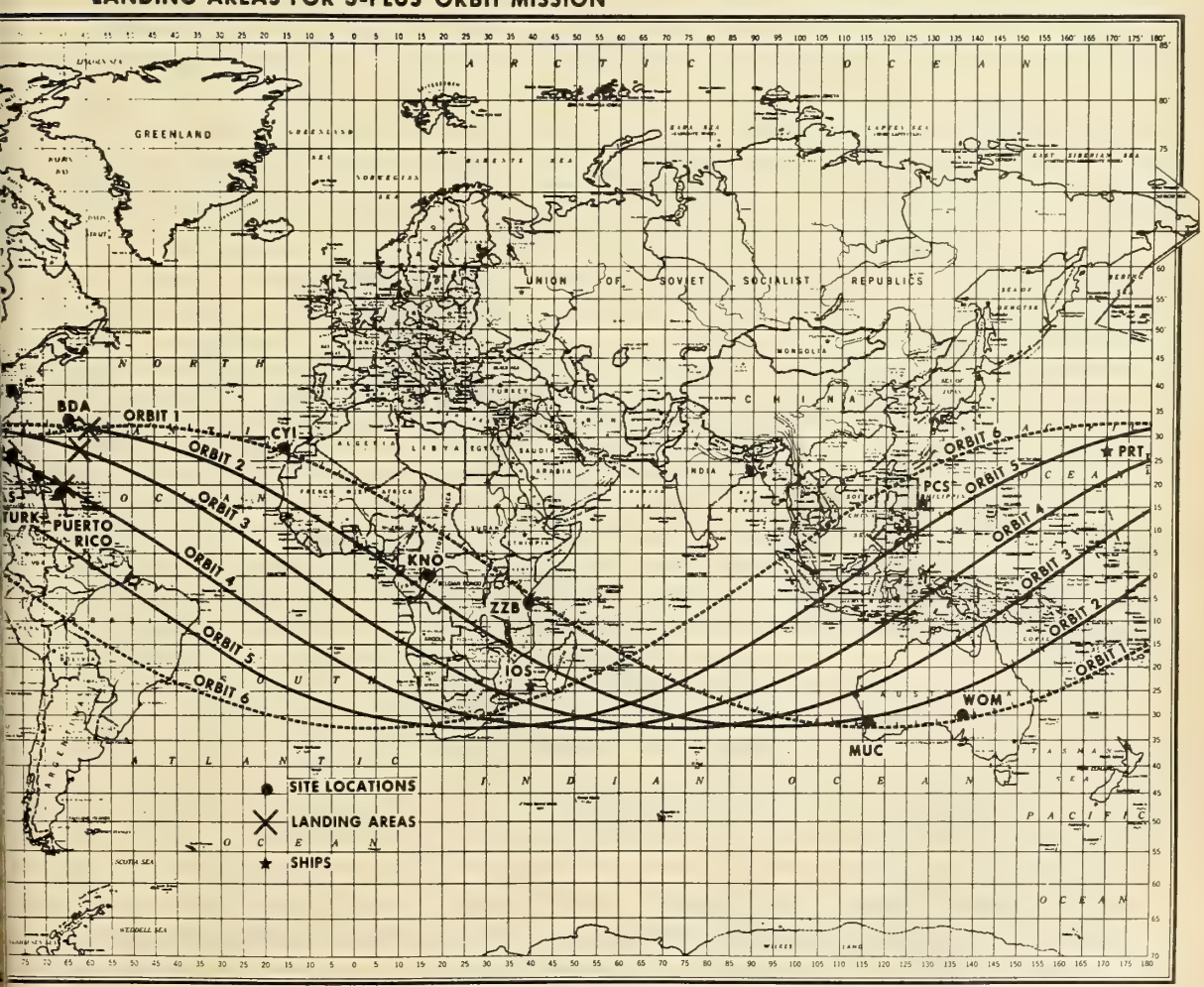
• **The sequence**—Here is how the *Apollo* mission will be accomplished, according to the NASA official:

One *Advanced Saturn* will be used to launch the spacecraft's command and service modules and the two-man vehicle into a parking orbit around the Earth. The third stage of the big booster will then be fired to send the payload on a trajectory to the Moon. The service module propulsion system will then be used to brake the spacecraft's speed so that it can go into lunar orbit from 50 to 100 miles.

Once in a lunar orbit, the two-man vehicle will disconnect from the spacecraft and, using a storable liquid propellant system, begin the descent to the lunar surface. One astronaut will remain in the command module. After the lunar landing, the ferry will launch from the Moon and rendezvous with the orbiting spacecraft.

The two-man crew will return to the command module and the lunar-landing vehicle will be jettisoned. The service module propulsion will then be used to send the spacecraft on its return trip. Prior to re-entry, the service module will also be jettisoned. ✠

GROUND TRACK AND PRIMARY LANDING AREAS FOR 3-PLUS ORBIT MISSION



for Mercury-Atlas flights of more than three times around, with indicated landing areas.

Telstar To Be First Active ComSat

First privately built satellite launched at private expense, it is expected to transmit live transatlantic TV

THE U.S. WILL ATTEMPT this week to launch American Telephone and Telegraph Co.'s *Telstar* — the world's first active communications satellite.

If successful, it will mark the first transmission of radio and television communications by an active repeater satellite.

It also is the first time that a private firm has built a satellite and paid for its launching with its own funds.

Telstar will be launched from Cape Canaveral no earlier than July 10 on a *Delta* booster. The 170-lb. spacecraft will be boosted into an orbit with an altitude ranging from 600 to 3500 miles. Orbital period will be approximately 160 minutes.

Its main objective is to receive a radio signal from Earth, amplify this signal 10 billion times and retransmit the signal on another frequency. Telephone calls between 40 cities in the U.S. and Europe and live television viewed by a transatlantic audience will also be features.

Besides providing technical information for future U.S. communications satellites such as *Relay* and *Syncom*, *Telstar* also will carry a radiation experiment to determine the effect on communications of particle energy in the Van Allen belt.

• **The agreement**—AT&T will build four of the satellites, including two backup vehicles. If a back up for the upcoming attempt is needed, the launch will be made in September.

Under its agreement with NASA, AT&T will pay the space agency approximately $3 million for its launch services.

Other main points in the agreement:

—The Bell Telephone Laboratories will design and build the *Telstar* satellites at its own expense, test them according to NASA specifications, and deliver them to the launch site at Cape Canaveral. The launching and two optional backup launchings were included in the agreement.

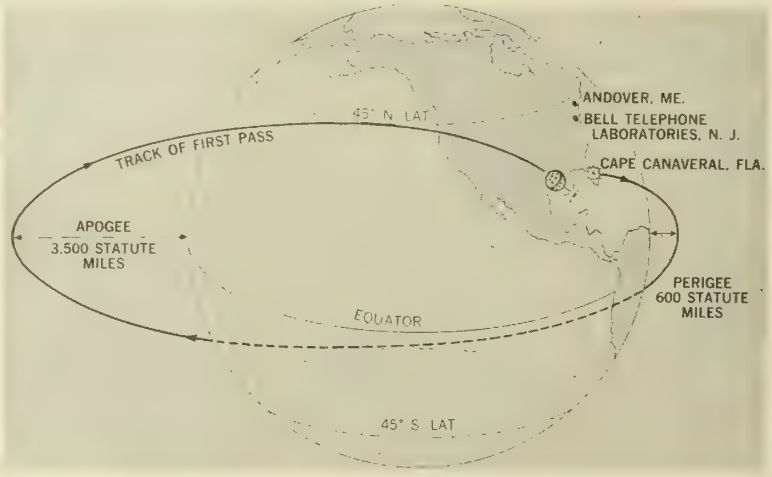
—Bell System engineers and scientists will conduct the communications experiments—television, voice and high-speed data—using the company's ground stations at Andover, Maine, and Holmdel, N.J. Results will be reported to NASA.

—NASA will provide Bell Telephone Laboratories with telemetry and space-craft acquisition information, including data from the radiation experiment received from world-wide Satellite Instrumentation Network. (These stations are located at Blossom Point, Md.; East Grand Forks, Minn.; Ft. Myers, Fla.; College, Alaska; Mojave, Calif.; St. Johns, Newfoundland; Woomera, Australia; Windfield, England; Johannesburg, South Africa; Antofagasta and Santiago, Chili; Lima, Peru; and Quito, Ecuador.)

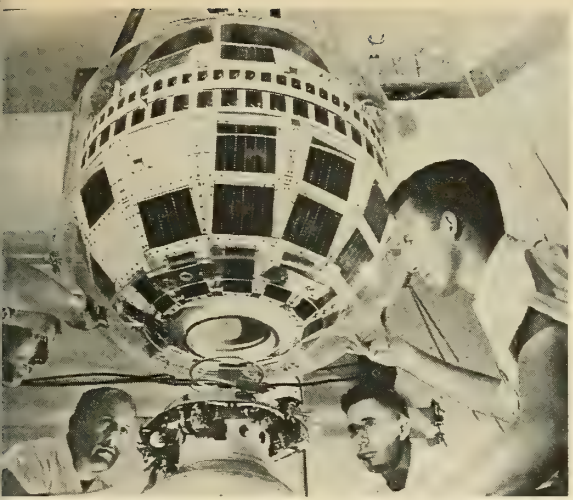
—NASA and Bell Telephone Laboratories will analyze the data and all results will be made available by NASA to the world scientific community.

• **Make-up**—*Telstar* is roughly spherical in shape, with 72 flat faces, or facets. It is 34½ in. in diameter and weighs about 170 lbs. The metal framework is made of magnesium, the shell of aluminum—coated with aluminum oxide sprayed on by a plasma jet process.

Solar cells are mounted on 60 of the facets. On three facets are mirrors that will reflect sunlight to ground observers using optical tracking equipment, and thus provide information on the angle



SKETCH OF THE first orbit of Telstar. Each orbit will take about 160 min. During the first four orbits the satellite will not be "visible" to the Andover, Maine, station. When it appears, some 12 hrs. after launch, technical tests will be conducted by Bell Telephone Laboratories scientists at Andover and Holmdel, N.J. Attempts will be made to transmit signals carrying voices and pictures. For the first two weeks Telstar will be visible during portions of five orbits each day. These periods will vary from a few minutes to about 50 min. for U.S. stations, from a few minutes to almost a half hour for mutual visibility between Andover and Europe.



DOUGLAS Aircraft Co. technicians mate the Bell Systems' Telstar experimental satellite to the third stage of a Delta rocket.

of the satellite axis in space.

Two antennas, equator-like, girdle the satellite. These are the receiving and transmitting antennas for the basic communications function of the satellite; they also transmit a precision tracking beacon signal. The antennas transmit and receive with nearly equal efficiency in all directions except in the direction of the "poles" of the satellite.

During launching, the satellite is given a spin of 180 revolutions per minute about this "pole" axis. The spin gives the satellite gyroscopic stability so that the poles tend to point to the same place in space although the direction will change very gradually over weeks or months.

Direction of launch is so arranged that during the first few months of satellite life the satellite axis—and its dead spots in the antenna transmitting pattern—will not point directly toward the Earth when the satellite is over the northern hemisphere.

Another antenna, a wire helix, is located on top of the satellite. This spiral antenna will serve telemetry, command and beacon circuits.

The satellite contains one electron-tube and 2528 semiconductor devices—1064 transistors and 1464 diodes.

• **Broadband communications circuit**—Signals are sent up to the satellite on the frequency of 6390 megacycles, or 6.39 billion cycles per second, and down to the ground on a lower frequency, 4170 megacycles, or 4.17 billion cycles per second.

The incoming 6390 mc signal is mixed with the output of a quartz crystal-controlled heat oscillator to produce a signal centered at an intermediate frequency of 90 megacycles. This lower frequency is within the range of reliable, long-life transistors. Fourteen germanium (diffused-base) transistors will be used to amplify the signal about one million times during normal operation.

Total amplification will be held by an "automatic gain control" to within set limits. Thus the output of the satellite will be very nearly constant—about 2¼ watts—regardless of the strength of the signal coming in from Earth, and regardless of slight aging of transistors or other small variations in the amplification circuit.

The amplified 90 mc signal will then mix with another crystal-controlled oscillator frequency so that the resulting mixture is centered at the 4170 frequency for re-transmission from the satellite. But before transmission it will be amplified once more by the only electron tube in the satellite.

The traveling-wave is a foot-long, pencil-thin glass tube containing a spiral wire. For size and weight, a traveling wave tube is the only device in the world capable of such amplification (10,000 times) with such a broadband signal.

The *Telstar* satellite will not, however, give the traveling-wave tube its first ride into space. Another, similar version has proved its ruggedness in the Bell Laboratories-Western Electric command guidance system aboard missiles—and will in fact be used again aboard the *Delta* rocket to launch *Telstar*.

The traveling-wave tube amplifies also a 4080 mc single frequency signal along with the broadband communications signal. This 4080 mc signal will be transmitted at lower power—about two-hundredths of a watt—to serve as a beacon for precision trackers on the ground.

• **Power supply**—Power will be supplied to electronic circuits in the satellite directly by 19 rechargeable nickel-cadmium cells, of the type used in rechargeable flashlights but specially designed for the space environment. They will be charged by 3600 solar cells on the skin of the satellite.

The solar cell system will convert sunlight into electricity at the initial rate of about 15 watts while the satellite is on the sunny side of the Earth and while the Sun is perpendicular to the satellite's equator. It is estimated that the output of the cells will decrease to 11½ watts at the end of a year, due to the effects of nuclear particles in the Van Allen belt and micrometeoroid damage.

The solar cells are mounted on a ceramic base in a platinum frame and protected from bombardment by energetic electrons by coverings of clear, man-made sapphire. These materials and their bondings were all chosen with an eye to their endurance in space. The ceramic, platinum and sapphire, for example, all expand and contract with changes in temperature about the same as the solar cells themselves—a fact which is expected to enable them to remain bonded together for many years.

• **Demonstrations**—Domestic communication demonstrations are planned between the next four orbits (sixth and ninth orbits—beginning about fifteen hours after launch) using the Andover and Holmdel ground stations. Visibility periods for these four orbits range from about 20 to 50 minutes.

Plans for the initial domestic demonstrations include: a live telephone call between people at two different locations, a video tape, a facsimile transmission of a current news picture and the sending of high-speed data between two points.

Signals will be sent from the giant horn antenna at Andover up to *Telstar*. The satellite will receive the signals, amplify them ten billion times, and transmit them at a strength of 2¼ watts back to Earth. The extremely weak signals will be picked up by both Andover and Holmdel stations.

A transatlantic demonstration, produced by the U.S. television networks, is planned after the domestic demonstrations and technical tests have been successfully conducted.

This international program will not occur until the satellite has been in orbit for about a week. The television networks are planning to transmit about 12 minutes of current news events from a number of geographical locations in the United States. This segment will also be shown to U.S. viewers as a part of a longer program, expected to run from 30 minutes to one hour.

Other international demonstrations from the U.S. will include telephone conversations, and photo and data transmission. The voice demonstrations will include a hook-up between people in 20 cities in the United States and 20 cities in Europe. Ten such conversations can be carried out simultaneously. ⌗

After House report . . .

Next Centaur Launch Deferred Until Early '63

NASA HAS DECIDED not to attempt the next launch of *Centaur* until the first quarter of 1963, putting the upper-stage vehicle almost two years behind schedule.

The NASA decision came in the wake of a House Space Subcommittee report which strongly criticized the NASA-industry management of the program and asked the space agency to determine if a DX priority was needed for the project (M/R, July 2, p. 12).

Space agency officials refused to comment on the subcommittee's recommendations pending further study of the report.

They did say, however, that five development flights are scheduled in 1963 and four more in 1964. This, they asserted, will enable the vehicle to reach its planned 1964 operational target date.

This implies that the space agency will probably decide against the need of the nation's highest priority.

NASA officials said that it will be two to three weeks before their comments on the report will be ready.

Other recommendations included in a recently released committee report on *Centaur:*

—Close, continuing and centralized supervision and direction over the remainder of the program.

—An end to the practice of assigning military or civilian personnel as NASA project directors on a temporary basis.

—A General Accounting Office investigation to determine "if the interest of the government has been adequately protected under the (*Centaur*) contracts." The recommendations are the result of *Centaur* studies and hearings conducted by a subcommittee headed by Rep. Joseph Karth (D-Minn.).

• **Cause and effect** — The subcommittee's attention was drawn initially to the *Centaur* program as delays began to mount and important missions such as *Advent, Surveyor* and *Mariner* had to be revised or rescheduled. The recent cancellation of *Advent* is not attributed solely to *Centaur,* though the committee indicates it believes *Centaur* delays are a major factor.

"According to NASA officials, *Centaur* occupies a position of key significance in the nation's space program," the report said. "This fact was not just discovered. It has been known for a long time." Nevertheless, the program "appeared to have been a low-pressure effort during its entire history."

"General Dynamics Astronautics, the prime contractor, has been preoccupied with the *Atlas* ICBM program, and resisted, until quite recently, making any really significant changes in its management of the *Centaur* program, despite repeated urgings by NASA officials to make changes at an earlier date."

The government's management of the program also appeared to the subcommittee to have been inadequate. The report said that NASA's Marshall Center, with control of the program assigned to it since June, 1960, through January, 1962, engaged only in "putting out fires" as difficulties arose in the program.

The report quoted Marshall chief Wernher von Braun, who told the subcommittee the center lacked "the depth of penetration to anticipate the fire hazards." ⁂

NASA Moves to Gain Operational Ion Engine

NASA IS CALLING for bids on an ion engine system with a long-range objective of providing three-axis attitude control and station-keeping of a satellite.

Proposals are to be submitted by July 30. A contractor will be chosen within several weeks.

The RFP marks the first move of NASA's electric propulsion group toward operational engines capable of handling missions anticipated in the next two years. The ion engine system is low-powered—probably no more than 3 to 5 kw—and probably will utilize power sources other than nuclear.

Besides providing an operational system with a mission capability, the contract should go a long way towards settling the reliability question, says a NASA spokesman.

• **Confidence** — *The system will have to operate for at least a year and be able to withstand over a million stop-start cycles. Ground tests should be extensive simply because of the economics involved in any flight-testing program. But the acid test—which must be met before such an engine can be declared operational—is an orbital life shot. NASA experts are confident it can be done within the next two years with this low-power system.*

Electrical propulsion engines are plagued with a power source problem, at least in the high-performance areas. One NASA expert says it is unfortunate that nuclear power sources are so intimately tied to the engines, but the former looks like it can do the job and remains the best candidate. Nuclear power systems are, nonetheless, far behind electric engines in terms of development.

• **Proof of pudding**—*Once an electric engine is actually performing a space mission, says a NASA spokesman, the vast potential of the concept from both a dollar and a capability standpoint will be apparent to many who now impede their rapid development.*

From a logistics point of view, such systems are a necessity if the U.S. manned space effort is not to be just a grandstand play, he added. Supplying men on the Moon, through electrically propelled freighter vehicles designed to orbit the Moon, can be far cheaper and more reliable than any propulsion system currently in operation or proposed. And this could come almost as soon as the U.S. lands the first astronauts.

NASA electrical experts feel that there is too much defeatism in the face of highly complex power problems, and that not enough parallel efforts are being made.

Some of the firms bidding on the attitude-control ion system—which calls for power-conditioning equipment, engine controls, propellant storage and feed systems and electrical thrustors—include: Space Technology Labs, Goodrich High Voltage Astronautics, General Electric, Electro-Optical, North American Aviation, Thompson Ramo Wooldridge, Aerojet, Plasmadyne, Bell Aerosystems, General Dynamics/Pomona, and Westinghouse. ⁂

Test for new motors . . .

First Polaris A3 Launch Draws Near

by Robert Lindsey

FIRST FIRING of a *Polaris A3*, scheduled this month at Cape Canaveral, will be programed for a range of approximately 75% of its ultimate 2500-nautical-mile range.

Dubbed *A3X-1*, the test vehicle has been delivered to the Lockheed Missiles & Space Co. facility at Canaveral for final assembly and checkout.

The launching will be the first mating of *A3's* new high-energy motors—both stages cased in fiber glass' second-stage fluid injection thrust vector control and new Mark II lightweight guidance system.

Stan W. Burriss, *Polaris* program chief for LMSC, the *Polaris* prime, told MISSILES AND ROCKETS this week the *A3* design is now approximately 60% frozen.

He emphasized that the *A3* is not merely a follow-on to the *A1* and *A2* models, but is "an 80% new bird." Despite uncertainties of new technology, Burriss said Lockheed hopes to bring in the *A3* within the same time span and with the same number of test firings that were required for the 1500-mile *A2*, which was basically a growth model of the 1200-mile *A1*.

Burriss said virtually all subsystems of the *A3* have already been tested separately. Both first and second motor stages, made respectively by Aerojet-General and Hercules Powder Co., have been tested statically 30 to 40 times. The fluid injection TVC has been tested on several *A2* vehicles, as has been the basketball-sized MIT-GE Mark II guidance package.

Burriss feels that the decision to adapt the *A2* to fly various components of the *A3* has given the project a major head start. "We took the *A2* powerplant and used it as a basic vehicle to test various subsystems, so by the time we get the *A3* in the air it will have received a very thorough testing." He added that most of these component tests have been "highly successful."

Overall, the program is right on schedule, he said.

• **Schedule** — The first 10 to 12 shots he said, will be heavily instrumented and over-designed structurally, so range will not be an objective. These flights will probably travel less than 2000 miles.

The *A3* will have a different configuration than the familiar champagne-bottle shape of the *A1* and *A2* models, but will still fit the same basic "envelope" of 31½ ft. by 54 in.

Lockheed officials noted they are imposing a considerably stricter regime on design tolerances of the *A3* than were allowed in development of the first two models of the sub-launched missile. "Benefitting by past experiences, we have set much higher standards and are using a much tighter quality assurance system," one LMSC engineer said. Engineering is done under tighter tolerances and in the test phase, vehicles will be allowed a narrower span of deviation.

The tighter development discipline is required because of the compressed time alloted to development of the *A3*, which was accelerated by a year last year.

Burriss said no major problem is standing out in the *A3* program, but pushing state of the art over the entire development spectrum has been the basic job.

One design area making progress but still unresolved is fluid injection TVC. Required because of the high velocities of the *A3*, the development has posed engineering problems, but overall, the contractor is "highly pleased" with advances. What fluid will be used is undecided.

During tests, freon, nitrogen tetroxide, bleed-off from the combustion gases, as well as other fluids, have been used. Another design problem—nozzle development—is reported well in hand. Thrust termination is presenting no major problems, and underwater launchings of dummies of the new configured *Polaris* have been satisfactory at San Clemente Island, Calif.

• **Casing success** — Burriss is enthusiastic about progress in filament-wound casing development for the *A3*. "Growth of the technology has met all of our expectations," he said. The chief problem now, he said, is achieving consistency of quality and "reproducability" of the casings.

Although some test casings achieve the desired strength-to-weight ratio, the quality varies from casing to casing and the reason for the variability hasn't been pinned down.

But Burriss is optimistic this problem is relatively minor, and he believes there's room for a factor-of-three improvement in fiberglass technology.

From a development standpoint, he said, fiberglass casings offer a special dividend: a short lead time in making design changes. He said changing the design of steel casings requires a lead time of 12 to 14 months, while improvements on filament-wound casings can be pumped in within three to six months.

Although both motor stages will be fiberglass (only the second stage of *A2* is filament-wound), the interstage and instrument section will remain steel.

Present plans call for freezing *A3* design to about 98% of its ultimate configuration by early next year, when a pilot production line will be established. Establishment of this "proofing" line will include certification of tools by the Navy, training of personnel and general de-bugging of the production process. Delivery of the first *A3* missiles isn't scheduled until early 1964.

Less than 20% of the tooling developed for the *A2* production will be usable in the *A3* program. Similarly, launching and check-out equipment must be 80% new. In the change-over from *A1* to *A2*, the statistics were reversed, with 80% of tooling and GSE usable.

• **Speed-up**—In the *A-3* program, *Polaris* contractors for the first time will use the "mastering" concept in guages. Utilizing a metal master (a type of pattern) to achieve identical dimensions at the interstage and joints is expected to speed production and reduce waste.

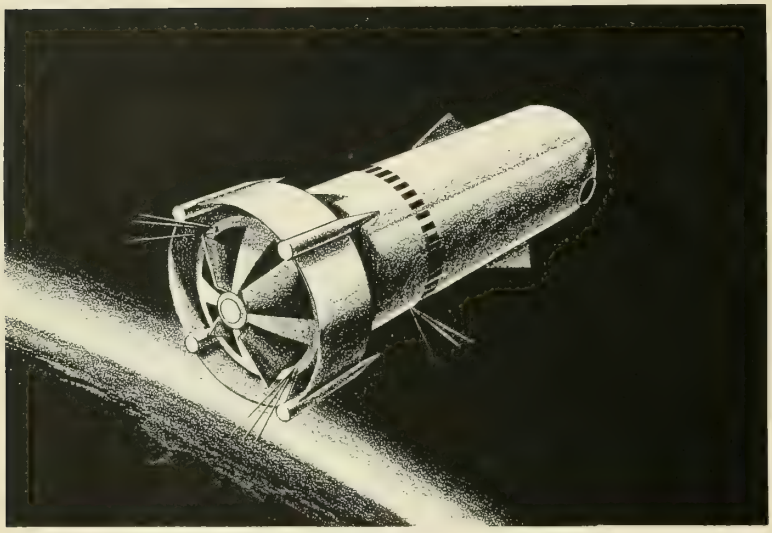
Production of the *A1-A2* models was complicated by the physical separation of Lockheed and Aerojet, the propulsion subcontractor. The contractors will now use identical masters.

While development of the *A3* is reaching a peak, a relatively small effort is continuing on a follow-on to the 2500-mile versions informally called *A4*. Preliminary studies have shown the feasibility of a *Polaris* in the 4000 to 5000-mile range, but so far the Navy has found no need for weapon beyond the range of *A3*.

The research program, involving about 10 engineers, is continuing to keep alive an option in case it's decided later that a long-range bird is needed. Present thinking is that the *A3* will be capable of hitting virtually all strategic targets and still give submarines enough sea room so that even expected post-1970 ASW techniques will make the weapon system concealable. ⌗

Based on films, photos . . .

Vostok II's Re-entry Design —An Educated Speculation



Artist's Concept of Vostok II

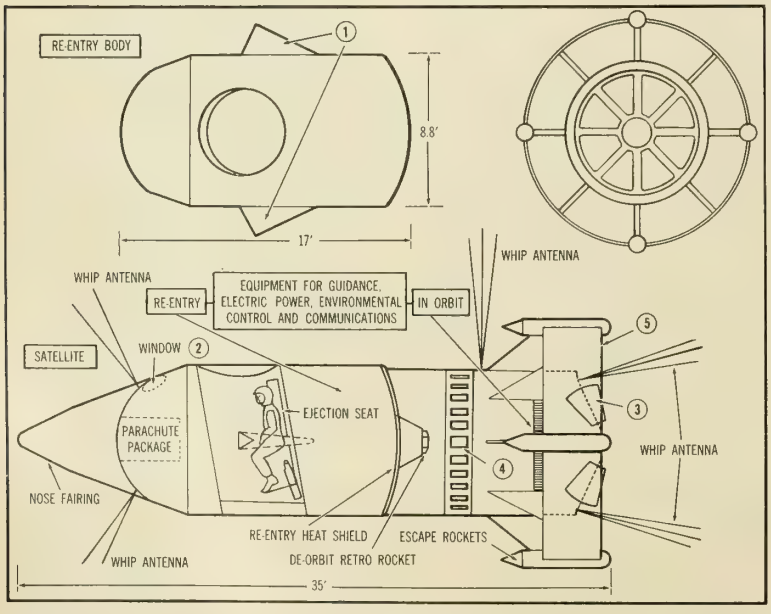


DIAGRAM OF VOSTOK II, based on external configuration. (1) Canard control fins for re-entry vehicle. (2) Protective cap over window. (3) Shutters for temperature control. (4) Ports for pressure release. (5) Stabilizer ring.

The Russians have given the U.S. no technical information about Vostok II. And during Gherman Titov's visit to the U.S. this past spring, it became obvious that they do not intend to.

Hence U.S. engineers have decided to figure out on their own how the spacecraft worked. An analysis made at a major aerospace concern follows.—Ed.

RE-ENTRY configuration of *Vostok II* was apparently arrived at with only limited use of readily available U.S. design information.

In October, 1961, a film of the Titov orbital flight film revealed some clue to the puzzle of the Soviet re-entry design.

• **Observations from film** — The more significant features included:

—One set of canard control surfaces mounted in reverse position.

—A metallic cap on spherical nose, resembling ship-type hatch cover.

—Shutters mounted on aft end, which open and close.

—A ring of small rectangular ports near aft end.

—A stabilizing ring at the base of the vehicle.

The internal arrangement of the vehicle, judging by the external configuration, reveals considerably more room than afforded by the *Mercury* vehicle. In addition, a circular window was observed above and to the right of the reclining cosmonaut.

The *Vostok* re-entry vehicle apparently used the *Mercury* technique for positioning the man so that he re-enters in a reclining position, facing upward. This simplifies the crew-restraint problem; loads can be applied to the cosmonaut in the same direction for both launch and re-entry.

As shown in the accompanying diagram, the single set of canards (1) are actually control fins for the re-entry vehicle. The reversed mounting of these fins indicates that the vehicle re-enters in an attitude opposite to that of ascent —as with *Mercury*. These surfaces trim the vehicle to an angle of attack permitting a limited degree of maneuverability. Roll jets, which could be mounted aft of the fins, would be used to maintain the desired roll attitude.

The metallic cap (2) is apparently a cover to protect a round window from aerodynamic loads and heating during ascent.

The shutters mounted on the aft end of the vehicle (3) indicate the location of power supplies, environmental control, guidance and communications equipments for in-orbit use. The shutters permit radiation cooling of the vehicle.

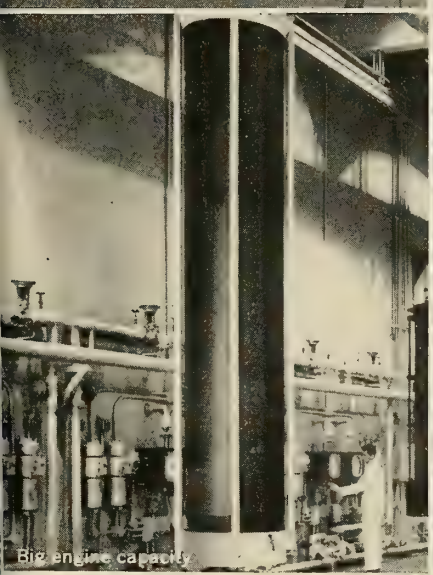
The small ports near the aft end of the vehicle (4) are probably blast ports for pressure relief. A retro rocket, which ignites before separation, would

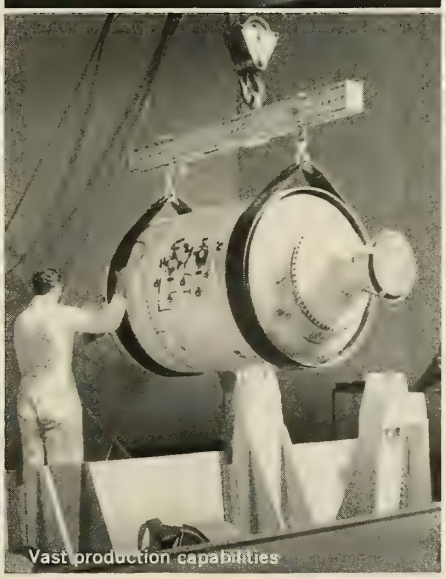
(Continued on page 34)











Pershing moves toward production

Reliable propulsion . . . on schedule. The ability to produce, based on pioneering experience and subsequent growth in the art, is helping to give the Army its most significant artillery weapon—Pershing. Propulsion for Pershing—designed and built by Thiokol—has the ruggedness, stability, and dependability needed for the quick firing, fast moving Army in the field. New production techniques, production capability founded on foresight, non-destruct inspection of finished engines—all developed by Thiokol in association with the Army—provide reliable fire power when and where it's needed.

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Denver Expanding Role as Space Age Center

Additions to Sundstrand Aviation-Denver's aerospace facility are the latest moves increasing the importance of Denver as a center of space age activity. Included in the facilities en route from the company's Pacoima, California division are:

A space vacuum altitude environmental test chamber, capable of simulating, under dynamic gas flow, altitude conditions up to 135,000 feet. This chamber was designed for evacuation of 2000 degree F gases at weight flows of 1000 pounds/hour. The exhaust system is a three-stage, 30-inch steam injector. It is contemplated that a fourth stage will be added upon installation in mile high Denver which will push the altitude capability to 250,000 feet. All of the supporting facility systems, fuels, electrical supplies and high pressure gases will be available to this chamber.

Altitude control can be programmed manually or automatically. Definite cam controlled altitude transients or altitude cycling can be programmed. Additional environments can be combined with altitude (temperature, from minus 85 degrees F to 300 degrees F, and relative humidity from 20 percent to 95 percent within a temperature range of 32 degrees F to 160 degrees F). This chamber can also be adapted for vibrating test items while they are being subjected to the above environments.

A Rucker centrifuge 22 feet in diameter will also be installed with a capacity of a 650 pound maximum test item weight on either or both ends of the arm.

It is rated at 20,000 g pounds, or 65 g's within 48 seconds. Fourteen 40-ampere power slip rings, three coax slip rings and 43 five-ampere instrumentation slip rings are available. In addition, a two-pass, 40 gpm, 3000 psig system and a hot gas exhaust rotary joint are also part of the installation. In excess of 2000 pounds of additional setup equipment can be mounted in the center and upon the arm of the centrifuge. A closed circuit TV system is provided for "close-up" monitoring of the test item.

This consolidation of operations is being done primarily for efficiency (lower cost, better communications, tighter detail control) and to bring into one location all of the facilities required for the research, development, testing and production of space-age hardware.

This Denver expansion should be of interest to you if you are any one of the following:

1 An Astronaut who will someday depend on a Sundstrand solar or cryogenic space power system to power all supporting equipment and keep the space vehicle "alive."

2 A "team member" of NASA, the Air Force, Army, Navy or a prime contractor to whom costs and delivery dates are vital.

3 A scientist or engineer who would like to give his family the opportunity to "really LIVE" in Colorado—while you contribute to the creativity and technical accomplishments of this modern, fully-integrated plant.

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INDUSTRIAL PRODUCTS GROUP

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Circle No. 5 on Subscriber Service Card

Technical Countdown

ELECTRONICS

Gaseous Optical Masers at Bell Labs

Two new gaseous optical masers—one using a mixture of oxygen and neon, the other a mixture of oxygen and argon—have been developed by Bell Telephone Lab scientists. The maser action is made possible through a dissociative excitation transfer wherein an excited atom of a noble gas breaks up an oxygen molecule. One of the resultant oxygen atoms attains an excited state immediately or shortly after the break-up and radiates the 8446-angstrom line. The mixtures are excited with a radio-frequency discharge. Maser oscillation takes place in a quartz-tube resonator.

Ceramic Generator Produced by Martin

A small strontium titanate rod with strontium-90 concentrated at one end has been developed by Martin Co. engineers to spontaneously generate its own electricity. The radioactive strontium-90 produces heat which is converted to electrical energy by the titanate through a thermoelectric effect. The AEC has awarded Martin a $63,000 contract to develop the concept.

Linear Integrated Circuit Perfected

A thin-film intermediate amplifier developed by General Electric is reported to be the first successful example of a linear integrated circuit. The four-stage amplifier operates on a bandwidth of 500 kc to 10 mc and exhibits a 60-db gain linearly over a temperature range of −60° to 160°C. The unit is vapor-deposited in seven layers on a glass substrate. Four microtransistors are thermocompression-bonded to the substrate. Four of the amplifiers are under evaluation at the Bureau of Naval Weapons.

Dispersed Laser Beam for Daylight Tracking

Daylight spotting of rocket boosters during launch phases may be achieved through a laser beacon optical tracking system. Electro-Optical Systems, Inc., scientists studied the problem under a NASA contract and proposed a 20-joule ruby laser with a frequency of 6943 angstroms—sufficient to track up to 500 miles every 10 seconds. The beam would be diverged by Cassegrainian mirror systems and fiber bundles, making the light visible from a variety of stations. Interference-type filters would be used with the BC-4 ballistic cameras. A 10-lb. liquid nitrogen dewar would cool the onboard laser.

Sun Sensor for Solar Panels

A triangular, 6-oz. Sun seeker perfected by Goodyear Aircraft Corp., which permits unattended operation of solar energy conversion power units, could easily be adapted to provide a constant energy influx for space vehicles. The unit requires no auxiliary power. Operation of the sensor is based on the generation of electrical control signals by solar cells mounted on three sides of the device. When the sunlight changes from the apex of the triangle, the sensor feeds impulses to a relay which connects power from a battery to a drive motor rotating the panel to face the Sun.

AF Research May Aid Cancer Battle

Investigations into human speech at the Air Force's Cambridge Research Laboratories, aimed at developing methods for transmitting voice messages over extremely narrow frequency bandwidths, have led to a detection method for vocal-chord cancer. The diagnostic technique, while not a replacement for internal examination, turns up certain characteristic patterns in speech waveforms when growths of the larynx are present. In a test with 32 speakers, the technique caught 23 departures from the norm—and all of these had medical histories of laryngal disorders.

ADVANCED MATERIALS

Century Series Ablatives Updated

General Electric's char-forming Century Series resins may cover wider ranges of re-entry conditions than currently possible. The clear, castable resins have performed successfully in short-time, very-high-temperature exposures and variations on the basic material have been developed. The addition of glass mat reinforcement or quartz fibers aids in tailoring for specific needs such as thermal expansion matching or shear force protection.

Titanium Alloys Strengthened with Aluminum

Increasing the aluminum content up to 6.5% increases the strength of titanium-aluminum alloys while further additions of aluminum serve only to improve ductility. Battelle Memorial researchers came up with the data during an Air Force-funded study into the relationships between mechanical properties, alloy composition and microstructure of several high-purity titanium alloys.

AF Academy Gets Basic Research Lab

A basic research lab concentrating in the fields of chemistry and aeromechanics will be set up at the Air Force Academy by the AF Office of Aerospace Research. The lab, to be operated on a tenancy basis, will take advantage of Federal laws permitting the hiring of scientists above civil service pay scales. The facility is designed to increase in-house ability in basic research, and to foster scientific careers among top-ranking cadets. Initial annual budget is $850,000, but the location will make it possible to share expensive equipment already at the Academy.

Ultrasonics in Slip-Casting

Increases in the green density and green strength of ceramic specimens have been achieved by Aeroprojects, Inc., experts through the application of ultrasonic energy to plaster slip-casting molds. Activation allows the use of slips of high solids content which otherwise could not be poured. It also accomplishes rapid gas removal from the wetted walls and promotes uniformity in mixed density compositions.

Filament-Wound Case Market Grows

Aerospace needs take 27.1% of total reinforced plastics output; government policy slows development

by John F. Judge

THE BIGGEST SLICE of the total U.S. reinforced plastics market is going to the aerospace industry. Projected 1962 sales add up to $95,760,000—with 20% of this in filament-wound glass-reinforced structures such as solid-rocket motor cases.

The aerospace market is almost double that of its nearest competitor—boats, says Hsing Liu, vice president-sales, of Lamtex Industries, Inc. A total of 31,920,000 lbs. of reinforced plastic will find its way into missiles, space and aircraft applications before the end of this year. This is a 6% gain over 1961.

The filament-wound section of this market is expected to grow significantly in the next few years. "By 1965," says W. Ponemon, president of Lamtex, "75% of all rocket cases will be filament-wound, compared to 1 in 50 today." "Operational missiles" he added, "such as *Minuteman* and *Polaris*, are likely to use engine cases exclusively of filament winding within two years."

Ponemon also placed his firm in the running for large booster cases by saying Lamtex has the capability and experience to build 260-in.-diameter chambers.

The firm recently completed building an experimental case approximately the size of the *Minuteman* first stage—66.5 in. across and 22 ft. long. (M/R, Jan. 15, 1962, p. 22). The program was sponsored by the Manufacturing Technology Lab, Air Force Systems Command.

The cases exceeded specifications in the hydrostatic tests at Thiokol Chemical Corp. and each was under the target weight. Each withstood pressures above the specified burst requirement.

The firm went from 5-in. diameter chambers to the current 65.5-in. cases—a scale-up of 13 times. A 260-in. case would involve only a scale-up of only a factor of 4.

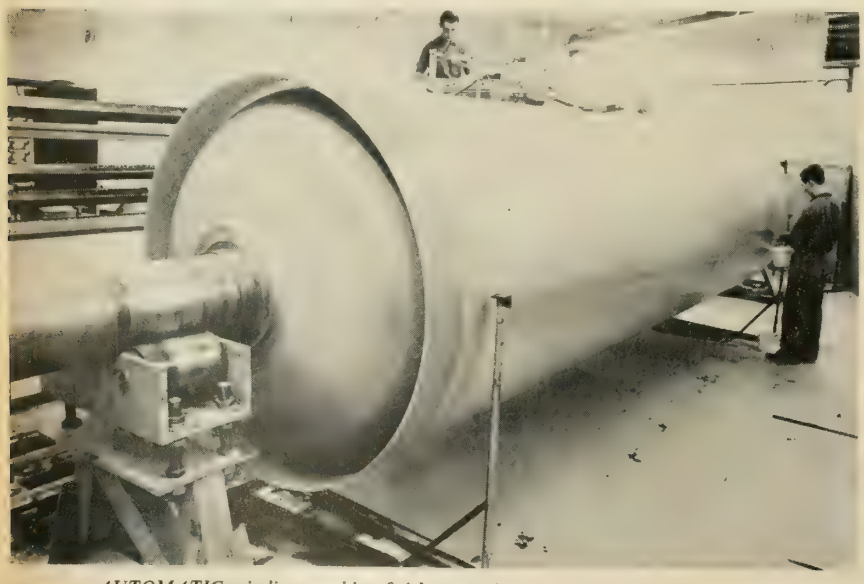
• **Glass vs. steel** — Ponemon cited the specific advantages of the Lamtex Hystran (glass fiber/epoxy) chambers as follows:

• Costs—Development costs in a program leading to delivery of a prototype case are 25% those of a similar effort in steel. After all development tooling and design modifications are complete, the production costs of Hystran cases are expected to be half that of a steel program and the tooling costs alone are 25% that of the metals.

• Delivery Time—The lead time involved in original design, tooling and prototype delivery of a steel case is 24 months while the first glass cases in the Lamtex program were on their way 5 months after initiation. The firm can deliver production cases 2 to 3 months after order, says Ponemon.

• Design and Performance—Glass cases have a higher strength-to-weight ratio than steel. The prototype cases at Lamtex were of a "very conservative" design and the finished weight was still only 87% that of a steel chamber.

Ponemon scored the government on this point. Such investigative programs as exist today, he says, are too conservative and prevent filament winders from



AUTOMATIC winding machine finishes massive experimental case at Lamtex Farmingdale, N.Y., plant. If more than two breaks occur in a fiber spool, it's discarded.



COMPLETED case rests near shipping container. Exceptionally stringent quality

exercising their full potential. Winders are not allowed to come in below the specified weight, even while meeting all other performance specs.

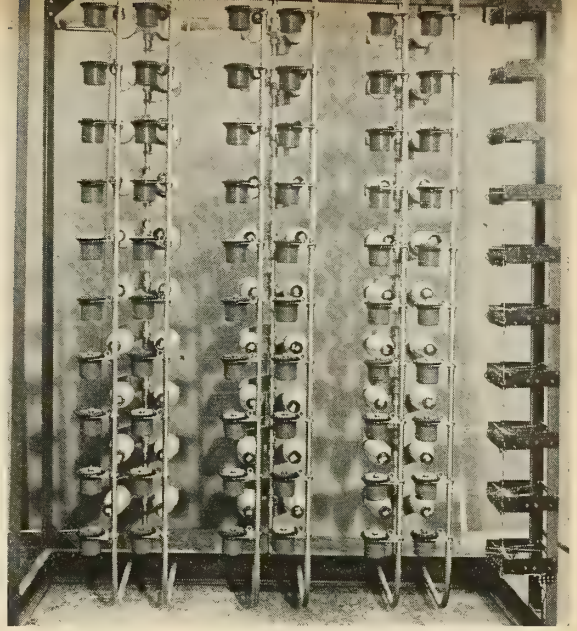
Lamtex could easily cut the weight of the 65.5-in. chambers to 60% that of steel through sophisticated flight-weight design.

Reinforced plastic is a thermal insulator, not a conductor. The same resins used in the glass case are those applied to metals for corrosion resistance. In flight, glass cases resist the scorching ascent heating, usually without the use of special external insulation materials.

• **High-powered inertia**—The major problems with filament-wound structures are technical and political, says Ponemon. The field is new and extremely fast-moving, with few, if any, design standards or design methodology. Lamtex develops its own techniques, designs and produces its own machinery and trains its own personnel. This problem is being met successfully, says Ponemon, but with a considerable investment in time, money and effort.

In this area, the firm is well on its way to automatic production with a new servo-controlled winding machine. Besides increasing production speed, the machine will permit greater flexibility in winding angles.

The second major problem is in handling. Filament-wound structures and their winding mandrels are huge affairs and their handling requires special knowledge and planning. If the time and money were available, the firm would probably develop re-usable steel mandrels and dispense with their current, plaster, break-out mandrels.



WINDING is monitored at Lamtex through series of magnetic brake tension devices with separate units for each spool in winding reels.

The higher cost of such mandrels would be offset by the improvement in production efficiency and greater accuracy.

Ponemon feels the biggest obstacle to the proper development and use of filament-wound structures in the missile/space area lies in the attitude of high level decision makers in government.

"There seems to be an all too prevalent non-acceptance, or non-belief of the capabilities of reinforced plastics," he says, and . . . "this is counter to proven facts.

"Many major advances in reinforced plastics, whether they be ideas, methods, or materials, must cope with such an attitude. But whatever the reason, the almost automatic tendency to dole out minimum budgets and often unreasonably short delivery schedules for reinforced plastic development and production has retarded the rate of progress," says Ponemon.

This also exists in the area of personnel. Ponemon says men with creative design ability in filament-wound plastics are rare—and those with actual experience are rarer still. The youthful president of Lamtex praised the Navy's Special Projects Office, indicating they were by far the leaders in applying reinforced plastics technology to missile and space problems. ⁂



control procedures are followed in production. The resin content is closely controlled.



THOUGH NOT a builder of metal rocket cases, Lamtex does thriving business in installing rubber insulation. Cost runs $1200-$1500 for large, complex cases.

Device Matches 'Noise' of Saturn

Northrop generator, built around specially designed valve, is used with two types of chambers

by Arthur H. Collins

HAWTHORNE, CALIF.—A laboratory-type noise generator capable of duplicating the high-intensity sound pressures produced by *Saturn*-sized rocket engines has been developed by Northrop Corp.

Designated the Nor-Aircoustic Generator, the device produces sound energy with intensities exceeding 160 decibels (db) by modulation of an air stream through variable-area ports. Port area variations are controlled by an electromagnetic driver. The modulation rate can be made to follow a complex, nonperiodic electrical signal.

The principle is similar to that of a siren. In the siren, however, modulation occurs at a periodic rate equal to rotor speed times the number of rotor ports. Siren-type sound, therefore, can be composed only of a fundamental frequency plus that frequency's harmonics.

• **Key valve**—Heart of the Northrop unit is a specially designed reciprocating poppet valve which modulates air flow. The valve is designed to withstand full-closure impact stress at the point of maximum stroke velocity, and is driven by a standard shaker table. Valve closure coincides with the shaker's electrical and mechanical neutral position for maximum acoustical output.

A spring flexure system couples the poppet valve to the shaker table after valve closure. The resulting valve motion is half-wave rectification of shaker table motion.

Another feature of the poppet valve design is large pressure differences with very small displacements. With a sine wave input to the shaker, a combination of half-wave motions plus the large initial and final pressure swings produces near-square output pressure pulses which travel down the horn. This pulse shape exhibits a strong harmonic train extending eight or more octaves above the fundamental.

With a random noise input signal to the shaker, valve motion produces a pulse train with random amplitudes, pulse widths and intervals. Narrowband analysis of the pulse train shows a smooth, continuous sound spectrum rising from 40 to 100 cps then rolling off at less than 6 db per octave.

The requirement for a continuous output spectrum is that the random input signal have a bandwidth greater than one octave. Northrop uses a 20 to 450 cps input signal bandwidth to optimize shaker power over a frequency range where suitable valve displacements produce the desired modulation.

A full frequency range output is achieved by generation of random harmonic bands to "fill" above the fundamental random input band. Output is primarily determined by acoustic impedance characteristics of the associated horn and chamber. Output is basically flat on an octave band basis if loading is non-resonant. Emphasis of high or low frequencies can be accomplished by shifting the air stream and exciter power balance.

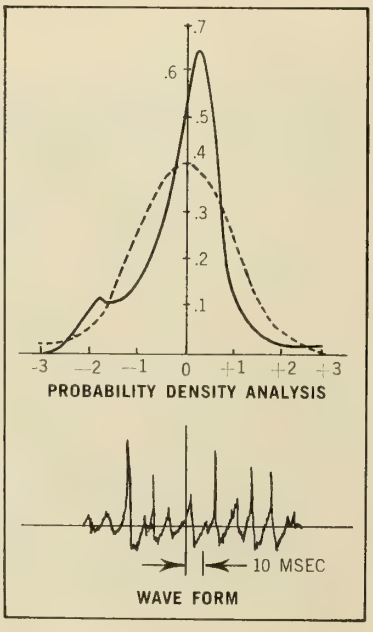


FIG. 1—*A typical progressive wave chamber pressure wave.*

The unit may be driven by almost any electromagnetic vibration exciter or shaker table producing from 1200 to 1500 force-pounds. A 6-kva power amplifier is required. Most random vibration equalization systems can provide the required signal, but a Northrop-developed input package is generally used so the more complex and expensive equipment is not tied up.

The input package provides all shaping necessary for modulator control. To produce the rated power, an air system with a flow of 90 pounds per minute at 200 psig is required.

The valve has undergone a number of design modifications to improve system capability. The current Mk. 5 production model valve can be used with any chamber or load. A Mk. 5 has been purchased by Boeing, and Northrop has submitted a bid to another company for a complete acoustic test installation.

• **Choice of chambers**—Two types of test chambers have been built by Northrop for the acoustic generator—a reverberant chamber and a progressive wave chamber. The generator can be coupled to either type.

The reverberant chamber is best suited for simulation of acoustic energy effects upon a missile or space vehicle's internal environment and is used for test of electronic hardware—guidance, radar or instrumentation. This is a long-familiar area to Northrop—beginning with early *Snark* studies where electronic compartment sound levels were found to be as high as 187 db. This is about 20-db greater than that generated by the *Saturn* engines.

Internal chamber volume is 170 cu. ft., including the horn. The interior form is pentagonal, with an inscribed circle diameter of six ft. The ceiling has a 14-degree slope with respect to the base. A 100-cps hyperbolic horn adapts the modulator to the chamber. Both chamber and horn are built of 12-in.-thick reinforced concrete.

The progressive wave chamber has its greatest use in simulating external environmental conditions for missiles, space vehicles and aircraft. A need for this type of acoustic testing showed up in *Snark* and B-47 development.

The Northrop chamber is slightly over 20-ft. long, and consists of a 16-ft.-long, 30 cps, exponential horn followed by a constant area section 4 ft. wide and 9 in. deep. A termination muffler is attached at the chamber's end to reduce formation of longitudinal standing waves for frequencies greater than 30 cps.

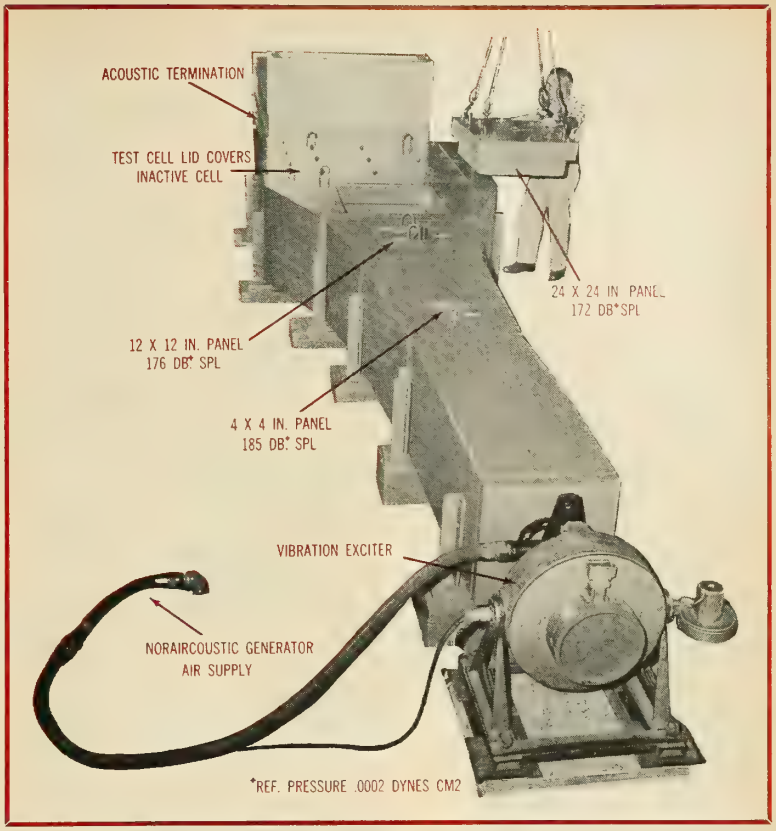
• **Four cells**—A chamber includes four test cells varying in physical size and position in the test stream. An overall efficiency of 33% is achieved with 43.6 kw of power at a point 6 ft. down the stream.

A typical progressive wave chamber pressure wave is shown in Fig. 1. The negative peak clipping level represents −1 atmosphere at the valve throat. Positive peaks of +4 atmospheres occur with some finite probability as shown in the probability density analysis. Very slow area expansion imposed upon the signal by the 30 cps horn preserves the skewed form. This wave shape is lost in the reverberant chamber because of its multiple reflections and more rapidly expanding horn.

Peak of the probability density function depends upon horn expansion rate and total acoustical power. A narrow-band power spectral density analysis of the wave form shows a continuous spectrum, predictable from the ⅓ octave band analysis. The rms structure response to this input is predictable from the power spectral density, and fatigue life of the test article can be correlated to the mean frequency of exceedance.

The prediction of total acoustic power for any combination of available air supply and shaker force is shown in Fig. 2. Input requirements for a given power level can be determined. Some high-frequency loss can be expected for both large diameter valves and low supply pressures (below 30 psig).

Both chambers have been designed for inclusion of other environmental conditions with the acoustical environment. To provide a facility with launch and re-entry random vibration testing, programed shock and transient temperature effects can be added on a rational basis. The progressive wave chamber also provides for static loading of structural specimens. ❖



PROGRESSIVE wave acoustic test chamber, used mainly to simulate external environmental conditions, includes four test cells of different sizes.

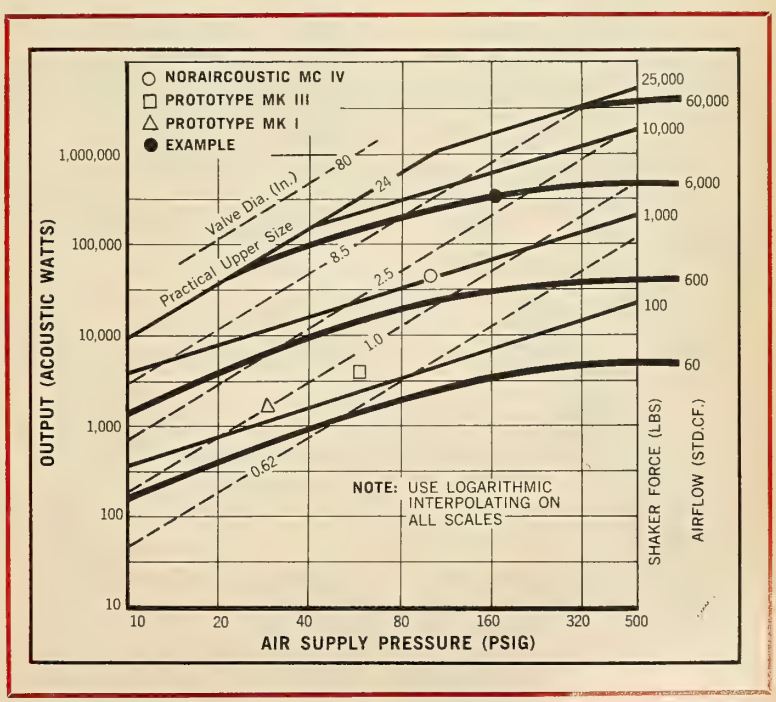
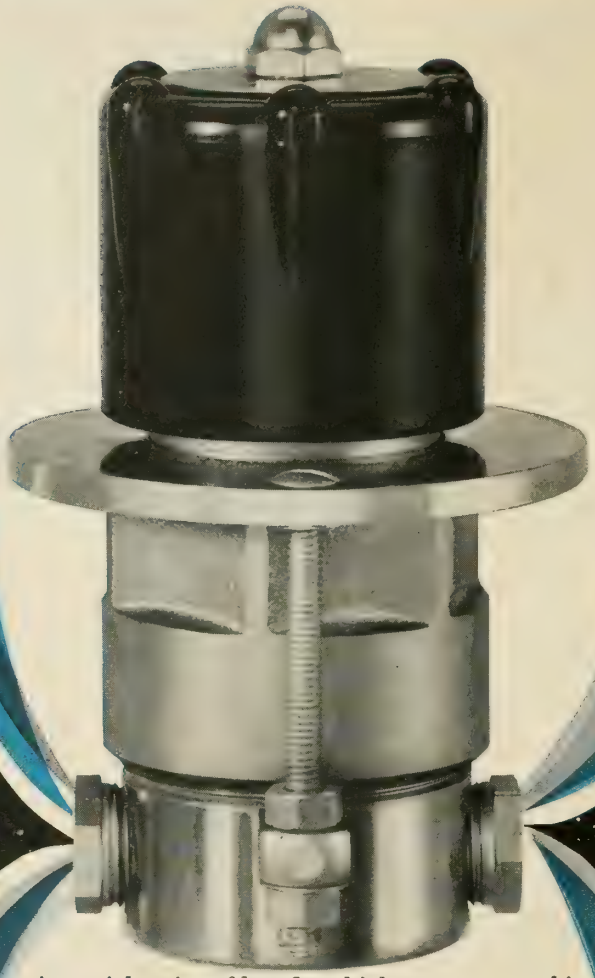


FIG. 2—*Total acoustic power prediction for varying air supply and shaker force.*

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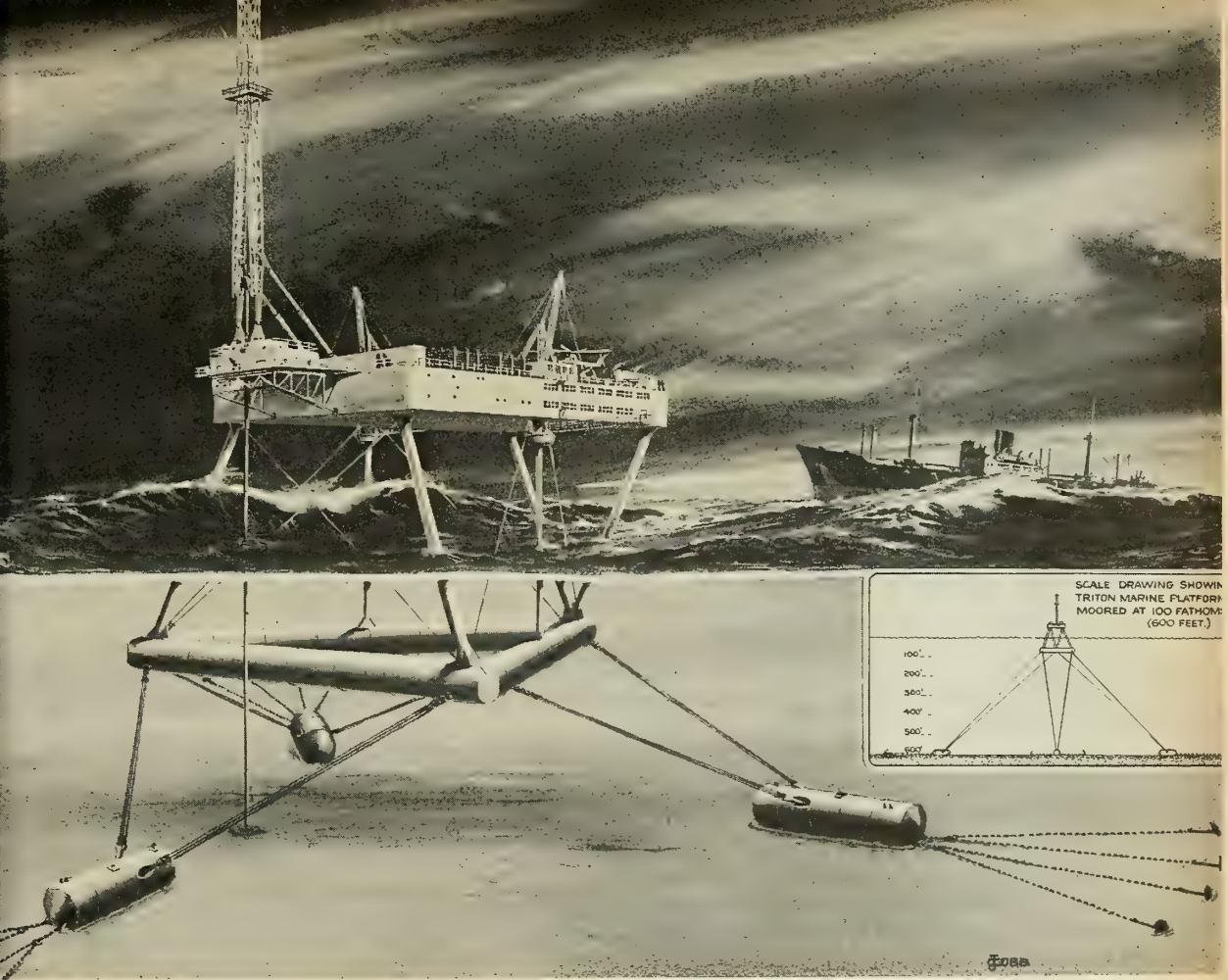
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ARTIST'S concept shows Triton used as drilling rig.

international

British Propose New Sea Launch Pad

by G. V. E. Thompson

LONDON—A radically new type of marine platform for tracking and launching missiles has been proposed by two British concerns interested in extending the use of moored platforms.

It reportedly could be anchored in water exceeding 100 fathoms — the depth at outskirts of the continental shelf. This presumably would make it more versatile than the Air Force's "Texas Towers," which are limited to about 30 fathoms for anchorage.

Known as the "Triton" platform, the structure was developed by Intercontinental Marine Development Ltd. of London, and Cammell Laird & Co. of Birkenhead. Cammell Laird has been given the worldwide manufacturing and selling rights.

• **Big payloads**—The Triton is said to be capable of carrying from 25 to 1000 tons payload, and to have exceptional stability even under hurricane conditions.

Developed originally for undersea oil drilling, the platform can also be used for antisubmarine action, ocean meteorological stations, geological surveying, air and sea navigation, radio and visual beacons, offshore port facilities and helicopter landing platforms.

Specifications call for stability with 50-ft. waves at 15-sec. periods and up to 120 knots wind at sea surface (hurricane conditions); under these conditions, a two-degree azimuth displacement (2 Ft.) is allowed. Under storm conditions (30-foot waves), one-half-degree azimuth displacement is permitted.

The basic structure is a platform with hollow struts linked to a triangular buoyancy chamber held on location to the sea bed by taut cables attached to sinkers held laterally by anchors (see diagram).

The buoyancy chamber is built like a submarine hull. Its triangular shape ensures maximum stability both when the platform is towed to site with tanks "blown" and floating on the surface of the water, and when the chamber is below surface on-site.

The lower ends of the cables are held on the sea bed by a series of sinkers held in location laterally by spaced anchors. The buoyancy of these weighted sinkers, which consist of cylindrical steel vessels divided by bulkheads into a series of watertight compartments containing ballast, is controlled by means of permanent air lines. ⌘

On-Board Orbit-Change System Nears Flight Test

by Michael Getler



KEY ELEMENTS in Arma's Orbiting Velocity Meter include, left to right, the velocity comparator, vibration-string accelerometer assembly, and accelerometer control unit.

GARDEN CITY, N. Y.—An onboard system designed to allow precise changes in a satellite's orbital path is being produced here at the Arma Div. of American Bosch Arma Corp.

The device, called an orbiting velocity meter (OVM), conceivably could play a key role in any military or civilian space agency scheme for rendezvous, satellite inspection, or re-entry. It was originally developed as a company-funded project, but Arma has now been turning out flight hardware packages for about six months under government contract. First flight tests of the system are said to be "not far off."

Essentially, OVM performs its function through two key elements, an inertial sensing unit and a microminiaturized digital computing device.

• **Comparator** — The digital element, or velocity comparator, can receive and store velocity information in digital form which is either pre-flight programed or transmitted through a ground-to-air rf link while the satellite is in orbit. The latter case could occur, for example, if the satellite had an inspection mission and new tracking data were acquired on a possible hostile spacecraft while the OVM-equipped craft was already in orbit.

• **Accelerometer**—When a change in orbit is required, a signal from the ground initiates engine fire aboard the satellite. The inertial sensing unit (a vibrating-string accelerometer) immediately detects the change in satellite velocity and feeds a natural digital output directly to the velocity comparator where the signal is compared with the stored data describing the required orbit.

When the measured velocity agrees with the command data, a signal is generated in the computing unit which serves to shut down the spacecraft's propulsion unit or any other velocity component instantaneously.

Provision is also made for continuously monitoring OVM performance, including accelerometer output, via a telemetry link; this provides a ground control station with an immediate indication of engine operation.

Arma engineers on the project emphasize the inherent closed-loop aspect of the OVM system, which allows accurate and reliable in-flight control of engine shutdown as opposed to a system which depends upon ground control for both operations.

In addition to obvious applications in making major orbital changes, company officials also point out that using the device in conjunction with a throttle-controlled engine could be extremely helpful in providing continuous satellite drag corrections.

• **Packaging arrangement** — In its current form, the OVM is being packaged in three separate modules: an accelerometer control unit, the vibrating-string accelerometer assembly, and the velocity comparator. The entire system, which is body-mounted and thrust aligned, reportedly weighs less than 18 lbs. and requires 30 watts power during orbital change operations. Standby power required for the system is 3 watts.

The OVM works off a standard 28-volt dc supply, requires no external cooling apparatus, and can operate continuously under high vacuum conditions within a 0-160° temperature range.

The accelerometer control unit contains the vibrating-string oscillator and auxiliary electronics, including a zero-drift compensation system and a temperature control amplifier for the accelerometer package. The standard Arma vibrating-string accelerometer employed in OVM is housed within a conventional vibration isolater. Arma also used a vibrating-string type accelerometer in the *Atlas* inertial guidance system.

For the 6¾-in. x 6-in. x 6-in. solid-state velocity comparator, Arma used micromodule techniques developed during its proposal work on the AF's STINGS and 624 A *(Titan III)*. ⁂

ASME Mee

SPACE STRUCTURE problems from re-entry through the latest in thrust vector control were discussed at an Aviation Conference held at the University of Maryland recently by the American Society of Mechanical Engineers.

Program reviews were presented in selected areas of the *Explorer X*, North American's *X-15* and Grumman's *Orbiting Astronomical Observatory*.

The *OAO* presented a difficult problem in structural engineering: deformations are limited in all conditions of loading and environment. The primary problem was maintenance of alignment. J. Mockovciak, Jr., of Grumman Aircraft Engineering Corp., summed up the many unique design problems encountered in *OAO* by terming the program the beginning of an entirely new field of structural design—where the smallest detail received as much attention as the largest.

A highlight of the meeting was the award of the annual Spirit of St. Louis medal to Samuel K. Hoffman, president of the Rocketdyne Division of North American Aviation, Inc. The citation credited Hoffman with contributing to the development of the first long-range rocket-powered engine.

• **Glass liquid rockets**—Reinforced plastics may well be the next step in reducing the weight of liquid hydrogen tankage if the problem of permeability is solved says J. B. Esgar, chief of the Structures Branch, Lewis Research Center.

These seals must be effective, since leakage of liquid hydrogen into the insulation could increase thermal conductivity by one or two orders of magnitude—rendering the insulation almost useless.

In the present state of the art of cryogenic space tankage, aluminum (2014 T6), cold-worked austenitic stainless (AISI 301) and possibly an alpha-titanium alloy such as 5A1-2½Sn are contenders.

Esgar says the ultimate material is likely to be whiskers, especially in those structures where weight reduction is important enough to offset the high cost of the approach. The NASA expert says whisker research should be concentrated in the carbon or sapphire area rather than iron, since strength-density ratios already are higher for glass filaments than for iron whiskers.

Esgar pointed to meteroid protec-

eviews Thrust Vector Control Progress

on as a crucial area sadly lacking ufficient data for engineering design urposes. But available information in-icates considerable research is still ecessary to develop minimum-weight rotection systems. It seems reasonable, ays Esgar, that the thermal and me-eoroid protection systems will be com-ined to serve a dual purpose.

A new thermal insulation structure as described to the meeting by M. L. ill, J. M. Akridge and W. H. Avery of ie Johns Hopkins Applied Physics aboratory.

The concept consists of thin plates f a high-temperature alloy or ceramic ttached to a base structure at an acute ngle. The "shingles" are spaced so iat 90% of the insulation volume is omposed of air or combustion gases—ssentially in equilibrium with the static ressure on the surface by virtue of eakage paths across that surface.

In this manner, the authors say, erodynamic forces are transmitted irough the insulation to the base struc-ire. Thermal conductivities of the or-er of 0.1 Btu ft./hr. deg. F. sq. ft. at 2000°F, weighing approximately 1 lb./sq. ft., can be achieved with ordinary materials such as stainless, or nickel and cobalt-base superalloys.

The load transmitting function permits the use of shingles very near the melting points of the materials employed, because problems of creep and stress rupture are eliminated.

The absence of load-bearing requirements makes the concept amenable to application of brittle refractory materials—extending the usable temperature range up to 5000°F.

Further research at APL into higher Mach numbers and high-pressure environments is in progress; if it is successful, the shingles may be applied in combustor and nozzle areas.

• **TVC review**—A team of authors tackled the whole thrust-vector-control area. N. N. Fruktow, STL; L. E. Gatzek, Aerospace Corp.; and H. Howard, Vickers, Inc. covered TVC from jet-vanes through liquid- and gas-injection methods. A list of representative TVC nozzle materials, compiled by the authors, is in the accompanying table.

Representative Thrust-Vector-Control Nozzle Materials

Component	Desired Properties	Candidate Materials
Nozzle Throat Insert	Erosion 1 mil/sec. Resistance to thermal shock. Specific gravity. 2.0 gm/cm³.	High-density graphite (ZTA or AHDG) ATJ, pyrolytic graphite. Arc-sprayed W, vapor-deposited W, sheet-formed W, Refractory carbide and graphite, W-BeO.
Nozzle Throat	Erosion 2 mils/sec. Resistance to thermal shock. Lightweight, specific gravity 1.0 gm/cm³.	ATJ graphite. Graphite-cloth/phenolic. Fibrous graphite.
Nozzle Throat Retainer	Erosion 3 mils/sec. Char rate 5 mils/sec. Mechanical stress to resist moderate fabricating and thermal stresses.	Molded asbestos phenolic. Nylon/asbestos phenolic.
Throat Insulation and Support	Char rate 2 mils/sec. Lightweight, specific gravity 1.0 gm/cm³. Dimensional stability.	Molded asbestos phenolic. Asbestos phenolic.
Nozzle Exit Cone and Nozzle Base Insulation	Char rate 2 mils/sec. Lightweight. Specific gravity 1.0 gm/cm³. Heat barrier without char.	Nylon/asbestos phenolic. Zirconia (heat barrier under exit liner) asbestos phenolics. Tape-wound nylon/asbestos phenolic. Tape-wound asbestos phenolic.
Exit Cone Liner	Erosion 1 mil/sec. Resistance to thermal shock. Mechanical strength of at least 4000 psi compression to resist operating and thermal stresses when assembled in thin sections. Lightweight, specific gravity 1.5 gm/cm³.	ATJ graphite. Graphite-cloth/phenolic. Fibrous graphite. Shingle-laminated asbestos phenolic. Pyrolytic graphite.
Heat Barrier (Between exit cone liner and insulation)	High-temperature heat barrier. Non-charring.	Zirconia.
Exit Cone Retainer	Erosion 2 mils/sec. Char rate 3 mils/sec. Mechanical strength of 10,000 psi. Compression and shear. Specific gravity 1.5 gm/cm³.	Molded asbestos phenolic. Nylon/asbestos phenolic. Laminated nylon/asbestos phenolic. Refrasil phenolic Quartz phenolic.
Structural Shell	Stiffness (high E values) Lightweight. Fabricability.	Titanium. Refrasil phenolic, refrasil epoxy-novolac, aluminum sandwich (honeycomb) construction for very large nozzles.

Liquid and gas TVC systems, both inert and reactive fluids, have many advantages, they noted, including simplicity of design and a minimum of moving parts—the latter crucial in space-restart engines. There is also a definite weight advantage over current vectoring methods.

The parameters which must be optimized in liquid TVC systems are chiefly the location of the injection orifices and the nature of the fluid itself. The aim is to achieve maximum deflection for a given weight of injected fluid.

In solids, for instance, certain oxidizing liquids will provide additional deflection through combustion with the slightly fuel-rich products of the grain.

Hot-gas injection systems, which bleed from the rocket's combustion chamber into the TVC mechanism, eliminate the liquid storage and pressurization systems. But the authors say a much greater quantity of gas is needed over a comparable liquid system; the effect of bleeding from the combustion chamber on the vehicle's performance remains to be analyzed.

Test and accidental damage to the *X-15* rocket research plane was covered by F. R. Kostoch.

Permanent buckles were found in the craft's wing leading edge skins after a flight at Mach 5.25 and 110,000 ft., he reported. The wing edge has five segments of heat sinks; buckling occurred in the sections just aft of the expansion slots between each segment. This was eliminated by cutting the heat sink into smaller segments, flattening the buckles in the skin, adding an additional rivet to the fastener pattern attaching heat sink to skin, and spot-welding shields over the expansion gaps.

Of the two windshield failures in the program, one was due to inadvertent installation of soda-lime outer panel glass when a change to alumino-silicate glass had been specified. The second was caused by unequal retainer expansion; this was solved by substituting titanium alloy.

Two other accidents occurred—a hard landing at Rosamund Lake following an in-flight explosion, and a ground explosion resulting from a series of events initiated by a frozen pressurizing gas regulator.

In both of these, no unpredictable material or structural failure was involved. No weld failures were noted—a fact which astonished many designers. ⌘

soviet affairs

by Dr. Albert Parry

'Land rockets' in their industrial use

are discussed in a lengthy article "Make Way for the Land Rocket!" by a lady writer, N. Ilyinskaya, in the Moscow *Ekonomicheskaya Gazeta* of June 23. The tool is a drill motivated by "the burning of liquid fuel in oxygen" which expels a stream that essentially is the same stream "capable of sending a cosmic ship into outer space." The Russians call it also "a thermodrill," and Ilyinskaya notes that "this is a rocket of a unique kind," using kerosene for its fuel, and pushing gases out of its nozzle "with the supersonic speed of 2000 meters a second."

Mining is the principal field

of the rocket-drill's future employment. The cost of using the new tool in ore-drilling is quite high, Ilyinskaya writes, and 70% of the price is the cost of the oxygen involved. Yet there is little waste of the energy generated by such drilling when compared with the energy of ordinary drilling. The coefficient of usefulness of energy of the rocket-drill is 15 to 20 times higher than in conventional drilling, and brings down the overall cost of rocket-drilling to a level 10 times below that of the ordinary method.

The invention is 12 years old

and is credited to Professor A. V. Brichkin of the Kazakh Academy of Sciences in Soviet Central Asia. In his work he was assisted by A. L. Kachan, and a Soviet patent was issued in 1950 to both of them. But it was only in July, 1959, that the State Scientific-Technical Committee of the Council of Ministers in Moscow approved the model of the rocket-drill presented by Prof. Brichkin and his staff. The Committee sent the drill to the iron mines of Krivoi Rog in the Ukraine, and these soon reported that the novel tool did not work too well. Brichkin argued that manual instead of automatic handling of the rocket-drill was the main cause of the snag. He prepared a blueprint for automation, but the Krivoi Rog group would not bother to utilize the blueprint. They passed the buck to a machine-building plant in Buzuluk in the Trans-Volga area. And there the matter rested.

More than 2 years later Khrushchev himself

pointed an accusing finger at the Buzuluk laggards. He happened to spot a rocket-drill model in a newsreel. In a public speech in Moscow on May 10, 1962, he claimed that the rocket-drill was 8 to 10 times more productive than any ordinary drill, and in cost only one-third of the latter's cost. He shouted: "Yet, there are hardly any rocket-drills in our mines, except for four or five experimental models. Why? I phoned the comrades in charge and asked them to find out. They told me that the Buzuluk plant prefers to build old technology." He denounced the Buzuluk "bureaucrats" who "do not stir themselves, do not break the old, do not make way for the new."

It was in response to Khrushchev's thunder

that *Ekonomicheskaya Gazeta* sent its special correspondent Ilyinskaya to Alma Ata, the capital of Kazakhstan and the birthplace of the rocket-drill, to learn from the inventors the full story of the wondrous tool. Hence the article of June 23, which includes a summary of the several newest rocket-drill models improved by Prof. Brichkin's group. So 40 patents for that many various uses of the rocket-drill are by now held by this group. One model has been tried out successfully in cutting and polishing granite rollers for paper-making machinery. In an experiment in a Soviet Armenian quarry, a rocket-drill cut stone blocks 16 to 20 times faster than was done by conventional drills. To quote: "A square meter of a granite block's surface was finished in 40 to 50 minutes instead of the usual 12 to 18 hours." In Kiev, a rocket-drill cut—quickly and well—some concrete for powerhouse construction. In this last process, "a thermal mixture of ferric oxide and aluminum" was introduced into the rocket-drill's "gas torch" to control the temperatures of both the concrete and the drill's gas stream.

The Shape of Vostok II

(Continued from page 18)

be located on the heat shield. Whip antennas are mounted on the nose, midsection and aft end.

An outstanding feature of *Vostok* is the stabilizing ring at the base of the vehicle (5). This provides stability with a minimum drag penalty. Drag is extremely important when escape is initiated under high dynamic pressure conditions. Four escape rockets are attached to the stabilizing rings.

• **Observations from press photos**— The large hole in the side of the body is the location of an ejection seat. This method of recovery was emphasized in the film and has been mentioned in press releases. A large parachute system is probably provided to recover the re-entry body.

An ejection seat, a proven technique, is provided for the pilot. There was probably no system to prevent the capsule from overturning on landing—hence the ejection seat.

It was reported that a Soviet satellite, launched just prior to the Paris Summit Conference, was a test model of a 5-ton manned spacecraft. Our tracking stations reported that the satellite split into three parts when the retro rocket, apparently, fired in a reverse direction.

A separation line seems to exist in the photos, which leads to the conclusion that the re-entry body separates from the aft section of the vehicle. There are other discontinuities in the photograph which may correspond to supports and attachments required for helicopter transportation. The absence of fins is probably due to masking of the photograph.

• **Re-entry design summary** — The re-entry vehicle is a symmetrical cylindrical configuration with a blunt, spherical-segment heat shield—similar to *Mercury's*—and hemispherical aft end.

The vehicle is essentially a high-drag configuration with fins for trim to low-lift coefficients for limited maneuverability. Positions of the retro rocket and crew are similar to project *Mercury's*. Parachute recovery is employed, and an ejection seat and parachute are provided for the cosmonaut.

One feature of the configuration which may be desirable for application to some re-entry vehicle designs is the low-drag stabilization ring. The cylindrical configuration with spherical ends is an efficient pressure-vessel design, which would be relatively simple to manufacture. In addition, preliminary analysis indicates that this re-entry vehicle configuration would be dynamically stable. #

NASA Offers New Fast-Action Service

Managed by Documentation, Inc., system using IBM Computer is expected to yield major benefits to aerospace industry

by William Beller

A BROAD INFORMATION service to give space scientists and engineers fast access to needed technical reports —sometimes within minutes—is getting under way at the National Aeronautics and Space Administration.

Based in part on an IBM 1401 computer with random-access memory to keep track of the growing store of technical literature, this new service involves a method of high-speed information retrieval and dissemination plus a network of report-distribution centers.

It is an easy service to use: a biweekly journal operating on short deadlines provides abstracts and indexes in depth of technical reports relevant to space and aeronautics that NASA continuously acquires on a worldwide basis.

The journal goes to all authorized scientists; simultaneously, the technical reports are sent to NASA field installations and, in part, to participants in NASA programs. The documents are distributed either in full-size copies or in "microfiche" cards, 5-in. x 8-in. flat-films each containing up to 75 photographically reduced pages.

Operations are centered in an installation called the "Scientific and Technical Information Facility" (an acronym is not used), located at 4827 Rugby Avenue in Bethesda, Md. Managed by Documentation Inc., also of Bethesda, the Facility's program is directed by NASA's Office of Scientific and Technical Information.

This is said to be the first time a prime government agency has con-



FULL-SIZE COPY of typical "microfiche" card, distributed to NASA centers and contractors.

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Engineers to work in data reduction.
Scientists who know structures research and dynamics.
Scientists who have done supersonic aerodynamic research.
Scientists experienced in working with information and sensing systems, platforms, infrared, sensors, flight controls, airborne computing and data handling systems.
Engineers familiar with programming, operations, and instrumentation for ballistic missile flight test.
Reliability Engineers to assess the reliability and to optimize the configurations and mission profiles of space systems.
Chemical Engineers to work on the development and applications of structural adhesives for aerospace vehicles.
Metallurgical Engineers for research and development on materials and joining.

If you'd like more information about these opportunities and others that may be available by the time you read this, write and tell us about yourself. Contact Roy L. Pool, Engineering Center Personnel Office, 1001 East Broadway, Hawthorne, California. **NORTHROP**

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tracted out a major part of its information function.

• **Well along**—Although the Facility began operations only six months ago, it is already answering requests from NASA centers and contractors for technical reports, bibliographies and special literature searches. Alexander Kreithen, Facility director for DocInc., said that within a couple of months the Facility will be handling the entire assigned technical-information program.

Pointing up the efficiency of the new system, Kreithen said that all requests for available documents are answered almost as soon as they are received; as the system develops, requests for bibliographies are expected to be answered within less than 24 hours.

The Facility on April 12 published its first *Technical Publications Announcements (TPA)*, a bi-weekly journal whose predecessor had been used simply to announce new NASA publications. The new TPA—greatly revamped and expanded—is to cover annually between 25,000 and 30,000 NASA and relevant non-NASA documents, originating from foreign as well as domestic sources.

Appearing in unclassified as well as classified versions, the journals are to be timely: no more than four to six weeks is to pass between the date a technical document is received and its appearance in processed form in the TPA.

Starting from the time a TPA is issued, every document listed in it will be available at all NASA centers, either in full-scale form or on a microfiche card. A microfilm reader is used to bring the microfiche card up to size. All NASA contractors may eventually get a major portion of these cards, according to Paul J. Blaetus, assistant to the director of NASA's Office of Scientific and Technical Information.

This means that NASA contractors will have a complete set of NASA-acquired documents as close at hand as the nearest NASA center. They would, moreover, have in their company libraries most of the reports catering to their special interests.

Blaetus anticipates that the TPA's will shortly be sold on a subscription basis, although temporarily they are being sent free to qualified people. His office, headed by Melvin S. Day, processes requests for TPA's and will answer questions about the Facility's operation: city address is Washington 25, D.C.

A major objective of the program is to link NASA contractors to literature-search computers, in this way generating pertinent and timely biographies whose references will be found in the microfiche collections held by all NASA centers and company libraries. ⌗

GE Forms Missile & Space Division

General Electric Co. has formed a Missile and Space Division, with headquarters at the company's Valley Forge Space Technology Center, near Philadelphia. Under General Manager Hilliard W. Paige, the seven-component division operates as part of GE's Electronic and Flight Systems Group. At Valley Forge are the Spacecraft Department, Space Sciences Laboratory, Finance and Resources Planning Operation, and Legal Operation. The Advanced Space Projects Department is in King of Prussia Park, adjacent to the Space Technology Center. The Re-entry Systems Department is in Philadelphia, with additional space planned for Evendale, Ohio. The Missile and Armament Department is in Burlington, Vt.

"Creation of the new division," said a company spokesman, "is indicative of the significance General Electric attaches to missile and space programs, and reflects the company's extensive technical and physical investment in the future of this business.

"The new division will enhance the responsiveness of the company to changing conditions in the missile and space field and assure that its full resources are brought to bear on programs essential to national defense and to the nation's international posture."

The new division occupies some 2.8 million square feet of administrative, laboratory, engineering, test and manufacturing facilities, including the $32-million, 800,000-sq.-ft. Valley Forge installation.

The Missile & Space Division employs approximately 13,000 persons, some 2600 of them professional engineers and scientists including bio-chemists, biologists, ceramists, chemists, engineers, mathematicians, metallurgists, physicists, physioligists, and other disciplines. About 400 technical employees hold advanced degrees.

The division has overall responsibility for research, design, development, test and production of equipment and systems for armament, missiles, satellites and space vehicles for military and civilian purposes.

New Industry Facilities

Wyle Laboratories' Field Service and Support Dept. opened a new facility at Santa Maria, Calif., to better serve Vandenberg AFB and Point Arguello launch sites with component repair, functional testing, chemical analysis, calibration, inspection, certification, consulting and component and system cleaning. . . . *Atlas Connectors Co., Inc., division of Hermetic Industries, moved administrative offices from North Arlington, N.J., to corporate headquarters, Rosemead, Calif.* . . . Littelfuse, Inc., manufacturer of fuses, circuit breakers and associated electronic components, will build a 100,000-sq.-ft. plant in Des Plaines, Ill., to house manufacturing, sales, engineering and research facilities. . . . *Synthane Corp. will double the size of its West Coast fabricating and warehousing facilities at Glendale, Calif. The company manufactures and fabricates laminated plastics.* . . . The Lipe-Rollway Corp., Syracuse, N.Y., will build a 221,000-sq.-ft. manufacturing plant to house production and office facilities for its subsidiary, Rollway Bearings Co., makers of radial and thrust cylindrical roller bearings for the aerospace, industrial construction and transportaiton equipment fields. . . . *Vitro Engineering Co., Washington, D.C., branch, moved into new quarters in Silver Spring, Md.* . . . Electronic Modules Corp., Timonium, Md., expanded its plant facilities to include a temperature-controlled assembly area and an expanded engineering lab. The company engineers, develops and manufactures electronic circuit modules and related equipment. . . . *B. F. Goodrich Co. will put into operation a new two-story mixer building to increase production capacity at its Rialto, Calif., rocket motor plant. The new unit houses a 150-gallon solid fuel mixer and is part of an overall expansion program at the facility.* . . . AC Spark Plug, Electronics Div. of General Motors, opened a West Coast business office in San Bernardino, Calif., to service area customers.

Company Division Changes

Lear Siegler, Inc., realigned and renamed several divisions following merger of Lear, Inc., into the Siegler Corp. The Electronic Instrumentation Div., Anaheim, Calif., is the new name for the Hallamore Electronics Div., and the Astro-Structures Div. replaces the Hufford Div. The company also established a Data and Controls Div. which includes a new antisubmarine warfare laboratory facility in Connecticut. The division is a combination of the former Magnetic Amplifiers Div. and the military business portion of the Olympic Radio & Television Div. of the parent company. . . . *General Metals Corp. formed an ordnance systems engineering staff in Washington, D.C., to assist company research, development and production activities in numerous ordnance fields, especially aerospace and underwater defense.* . . . Allen Tool Corp., Syracuse, N.Y., established four major management divisions. . . . *Detroit Designing and Engineering Co. formed a new Transformer Div. to engineer, design and manufacture transformers, power transformers, filters, magamps and chokes.* . . . Corning Glass Works reorganized its Electrical Products Div. into three major departments: lamp, television and electronics.

New Names in The Industry

Biometrics Instrument Corp. has been formed in Dallas to research, develop and manufacture scientific instruments for bionics, medical electronics and space exploration. President is L. G. Coffey. The company is engaged in projects ranging from advanced instrumentation design to theoretical studies of manned space activities.

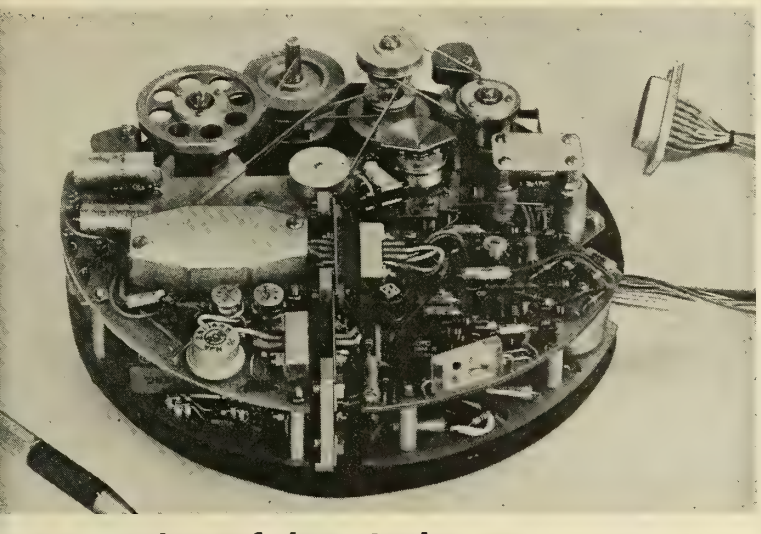


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New Product of the Week:

Satellite Tape Recorder

The Raymond Engineering Laboratory, Inc., has available a flexible Magnetic Tape Recorder for obtaining high-quality orbital and probe data. Designated Model 1598, it is a high-precision unit with extreme resistance to damage by vibration. Recording speed is 0.312 in./sec., with playback speed of 15 in./sec. Total recording time on its 160 ft. tape is 100 min., and playback time is 2 min. 20 sec. The recorder has a synchronous motor transport drive.

Power consumption in the record mode is 0.7 watt at 11 volts d-c-, and in the reproduce mode is 1.0 watt at 11 volts d-c. Its voltage range is from 11 to 14 volts.

Flutter characteristics are less than 1.5% peak-to-peak over bandwidth 0-300 cps.

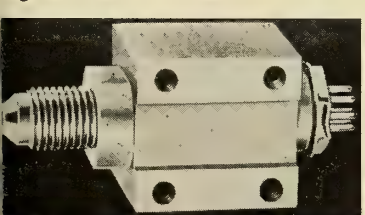
The recorder has 1 channel with provision for 2 with slight increase in height.

Circle No. 225 on Subscriber Service Card

Pressure Transducer

International Resistance Co. has available a solid-state variable mu pressure transducer, containing no moving parts, which handles overpressures to 700% without burst, and overpressured to 200% without calibration shift.

The Variable Mu is being offered in ranges from 0-100 to 0-10,000 psig. Devices are available in a-c to a-c



with 0.5 volts output into 10K ohms, with a 6-volts 400 cps input, and in d-c to d-c version with a direct 5-volt output.

Circle No. 226 on Subscriber Service Card

Digital Static Inverter

Astro-Space Laboratories, Inc., announces a series of inverters to supply polyphase 400-cycle ac from standard dc supplies. These inverters synthesize sinusoidal waveforms with ±1.0 volt regulation on balanced or unbalanced loads. Using all-silicon switching transistors and digital circuitry, their efficiency is better than 80% on full loads.

Circle No. 227 on Subscriber Service Card

High-Voltage Static Inverter

Microdot Inc. has available a compact 5-kva Static Inverter. Designed for submarines and operating from a wire-range d-c battery source, the inverter supplies up to 5000 watts of a-c power. Its conversion system allows an adjustable output frequency over the range of 380 to 2000 cps. No moving parts are employed in the unit.

The power conversion system inherently provides voltage regulation of ±1% maximum over an input voltage range of 190-360 vdc. Output power is held to 2% harmonic distortion and is virtually transient-free.

Circle No. 228 on Subscriber Service Card

Capsule-size 0.5-Watt Electron Tube

A tiny electron tube capable of withstanding intense vibrations encountered in certain types of military equipment has been developed by the Radio Corporation of America.

This 0.5 watt miniaturized nuvistor triode is expected to be evaluated for use in antisubmarine warfare equipment, aircraft-proximity warning systems, and other systems where compactness, light weight, and low power consumption are essential.

Circle No. 229 on Subscriber Service Card

Thermo-Resist 69

A room-temperature curing, flexible, ablative and high-temperature protective coating is available from Thermo-Resist Co.

A formulated organic material, Thermo-Resist 69 is a thixotropic material which is solvent-free, applied by brush, trowel, spray, or casting, and self-adhesive, bonding to most materials without use of primers or bonding agents.

Designed primarily for conditions of high shear and high heat input, 69 has a low K factor and a high ablative efficiency. It makes excellent lay-up material when used in laminating structures with materials such as high-silica leached glass.

Circle No. 230 on Subscriber Service Card

Block-Tape Reader/Handler

A block tape reader and handler is available from Chalco Engineering Corp. Model 623 operates without stor-



age or isolation circuits. The output is read directly from the reading head, which has 128 isolated SPST closures

with gold-plated contacts. Current capacity is 0.5A@ 28 VDC with pure restrictive load. Adjacent contact leakage is less than 400,000 megohms, so that dry circuits can be operated without isolation devices. Tape life is raised at 3000 passes, and an interlocking reading head, which prevents tape movement during opening or closing of the head, minimizes tape damage.

Circle No. 231 on Subscriber Service Card

Tantalum Capacitor Foil

Tantalum capacitor foil designated grade AA is available from Fansteel Metallurgical Corp. It is guaranteed to have a maximum direct-current leakage of only 0.5 micro-amps psi.

Also available is Class A foil with a maximum guaranteed d-c leakage of 1.25 micro-amps psi.

Circle No. 232 on Subscriber Service Card

X-Y Recorder

An X-Y plotter-recorder featuring 100 microvolt/in. sensitivity, solid-state circuits and dual-mode hydraulic damping is available from Electronic Associates, Inc.

Known as the Series 1110 Variplotter, the instrument produces an inked plot of two input voltages (X and Y) on either standard 11 x 17 in. or 8½ x 11 in. graph paper and will operate in any position, 0 through 360°. Static accuracy is 0.075% of full scale, dynamic accuracy is 0.1% at 10 in./sec. plotting speeds.

Circle No. 233 on Subscriber Service Card

Transducer Indicator

Bytrex Corp. has available the Model LCX-261 precision transducer indicator, which provides sensitivities from 1 to



400 millivolts per volt and is suitable for use with transducers from 60 to 1000 ohms.

It features instrument accuracy of 0.05%; a transducer supply voltage of 5 to 15 volts; a zero balance adjustment of ±50%; and remote sensing.

Circle No. 234 on Subscriber Service Card

Fast-Cure Epoxy Adhesive

An "assembly aid" for honeycomb sandwich structures, Epon(R) Adhesive 932, is being marketed by the Adhesive Dept., Shell Chemical Co. The adhesive permanently bonds, seals edges and caulks cells in metal, reinforced plastics and paper cores. It is useful also for embedding studs, inserts and other types of attachements in cores, and for fast repair of honeycomb segments.

The thixotropic adhesive is a low-density, microballoon-filled paste of low toxicity.

Circle No. 235 on Subscriber Service Card

Pressure Potentiometer

Plate-mounted miniaturized pressure potentiometers are available from Trans-Sonics, Inc. Designed for stack mounting and available in ranges from −5 to 300 psia in one basic miniaturized configuration, the units will withstand 35g to 2000 cps without fluid damping. Having a temperature sensitivity of less than 0.008%/°F and a 1 in. diameter, they are particularly suited for providing high-level signal outputs for missile telemetry or control systems.

Circle No. 236 on Subscriber Service Card

MISSILE GROUND SYSTEMS AT

AEROSPACE CORPORATION

Positions are available at Aerospace Corporation in Southern California and Florida for assignments in the planning and preliminary design of facilities and ground support equipment for future weapon and space launching systems.

These assignments involve site selection, safety analysis, silos, mobile launchers, propellant systems, gantries and ground handling equipment, as well as the planning of facilities for production, static test and component test.

Successful applicants will be required to perform such specific assignments as: preliminary design and cost effectiveness studies of ground systems for various weapon deployment modes; analyses of operational support and maintainability; development of new and economical concepts for launching and recovery; and the definition of ground support equipment, schedules and costs for future missile systems.

Candidates for these positions should have at least five years experience in the design, construction or operation of rocket static facilities, missile launching facilities, or ground support equipment. Broad knowledge of site activation problems, countdown procedures, propellant handling systems, and missile test requirements will be helpful. These positions require a B.S. degree in mechanical, civil or chemical engineering and ten to twelve years of professional engineering experience.

Qualified applicants are invited to contact Aerospace Corporation, an equal opportunity employer. Write to Mr. Charles Lodwick, Room 305, P.O. Box 95081, Los Angeles, California.

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contracts

AIR FORCE

$20,000,000—**General Dynamics Corp.**, San Diego, for installation and checkout of *Atlas* sites.

$12,000,000—**General Dynamics Corp.**, San Diego, for spare parts for the *Atlas* missile program (supplemental contract).

$10,055,571—**General Dynamics Corp.**, San Diego, for work on the *Nike-Zeus* program.

$6,781,628—**General Dynamics Corp.**, San Diego, for work on *Atlas* space boosters (supplemental contract).

$6,267,000—**Martin Marietta Corp.**, Baltimore, for research and development on the launch vehicle for a manned space program.

$5,934,000—**Boeing Co.**, Seattle, for procurement of *Minuteman* missiles and related equipment (supplemental contract).

$4,898,932—**General Electric Co.**, Pittsfield, Mass., for work on air weapons control system.

$4,609,235—**Aerospace Corp.**, El Segundo, Calif., for systems engineering and technical direction of ballistic missile and space projects.

$4,536,187—**General Dynamics Corp.**, New York, for work on *Atlas* missiles to be done at San Diego (supplemental contract).

$4,313,348—**Philco Corp.**, Philadelphia, for work on a control subsystem program at Palo Alto, Calif., (supplemental contract).

$4,276,289—**Boeing Co.**, Seattle, for follow-on research and development for *Minuteman* missiles (supplemental contract).

$3,100,000—**Martin Marietta Corp.**, Baltimore, for work on *Titan I* missiles and associated equipment.

$2,713,868—**General Dynamics Corp.**, San Diego, for research and development testing and fabrication of *Atlas* missiles.

$2,706,784—**United Aircraft Corp.**, East Hartford, Conn., for work on a classified project.

$2,383,000—**General Dynamics Corp.**, San Diego, for spare parts for the *Atlas* missile program (supplemental contract).

$2,279,000—**Martin Marietta Corp.**, Baltimore, for a study of design criteria for a standardized space launch vehicle *(Titan III)* and related work (supplemental contract).

$2,227,737—**Vitro Corp. of America**, Silver Spring, Md., for engineering services on *Talos, Tartar* and *Terrier* missile systems (2 contracts).

$2,000,000—**Space Technology Laboratories**, Los Angeles, for work on space programs (supplemental contract).

ARMY

$15,860,568—**Sperry Rand Corp.**, Salt Lake City, for production of *Sergeant* equipment and repair parts and work on test equipment (3 contracts).

$11,722,294—**Raytheon Corp.**, for field maintenance and ground equipment and items in support of the NATO *Hawk* program (4 contracts). Work to be done at Andover, Waltham and North Dighton, Mass.; Oxnard, Calif.; and Bristol, Tenn.

$9,443,634 — **Minneapolis - Honeywell Corp.**, Hopkins, Minn., for classified work.

$4,721,115—**Raytheon Corp.**, Lexington, Mass., for ground equipment and field maintenance equipment for *Hawk* missile system.

$2,227,733—**Western Electric Co.**, New York, for work on a classified contract at Greensboro, N.C.

$1,968,406—**Radio Corp. of America**, Moorestown, N.J., for TRADEX program (Target Resolution Discrimination Experiment).

$1,841,673—**Martin Co.**, Orlando, Fla., for production of repair parts for the *Pershing* missile system.

$1,594,500—**PRD Electronics, Inc.**, Brooklyn, N.Y., for test equipment to be used in connection with the *Nike-Hercules* systems.

$1,432,000—**Hayes International Corp.**, Birmingham, Ala., for *Pershing* missile trainer repair parts.

$1,173,000—**Raytheon Co.**, Lexington, Mass., for material to support the *Hawk* missile system.

$891,443—**Radio Corp. of America**, Moorestown, N.J., for automatic checkout equipment for guided missiles such as *Nike-Hercules, Lacrosse, Hawk, Sergeant* and the *Mauler* missile systems.

$50,000—**Planning Research Corp.**, Los Angeles, for a reliability study of the *Shillelagh* weapons system.

NAVY

$51,446,080—**Lockheed Missile and Space Co.**, Sunnyvale, Calif., for *Polaris* missiles.

$21,512,351—**Lockheed Missile and Space Co.**, Sunnyvale, Calif., for *Polaris* flight-test motors.

$17,170,000—**General Electric Co.**, New York, for fire control systems for the *Polaris* missile.

NASA

$5,300,000—**Ling-Temco-Vought, Inc.**, Dallas, for continued production of the *Scout* rocket.

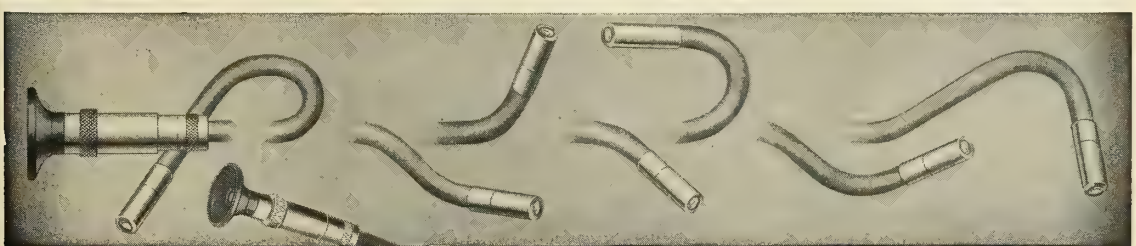
$160,000—**Ortronix, Inc.**, Orlando, Fla., for single sideband RM airborne telemeters.

ITT Federal Laboratories, Fort Wayne, Ind., for design, development, fabrication and testing of a boresighted star tracker and control logic unit for use in NASA's *Orbiting Astronomical Observatory* satellite program (undisclosed amount).

INDUSTRY

$21,512,351 — **Aerojet - General**, Sacramento, Calif., from **Lockheed Missile and Space Co.**, for *Polaris* flight-test vehicle motors.

$2,078,000—**Hercules Powder Co.**, Bacchus, Utah, from **Lockheed Missile and Space Co.**, for *Polaris* flight-test vehicle motors.



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Dr. Wendell B. Sell: Joined Packard Bell Electronics, Los Angeles, as group vice president.

Ray Tieger: Promoted to deputy director, Airborne Instruments Laboratory's Engineering and Production Div., Deer Park, N.Y.

Capt. Paul W. Gill (USN Ret.): Named manager of product field support activity at Ryan Aeronautical Co., San Diego.

O. F. Gamann: Named director of applied research, Transdata, Inc., El Cajon, Calif. **Thomas Tatham** named director of engineering.

Victor S. Thomason: Appointed sales engineer of Prosser Industries, Inc., Anaheim, Calif.

T. Ray Kelley: Joined the Special Products Div. of I-T-E Circuit Breaker Co., Philadelphia, as manager, new product development.

Francis M. Hope: Joined Dalmo Victor Co., division of Textron, Inc., Belmont, Calif., as manager of the ground support engineering department.

James H. McGarry: Appointed general manager of General Mills, Daven Div., Livingston, N.J.

Frank X. Dorigan: Named executive vice president of Dearborn Electronic Laboratories, Inc., Orlando, Fla.

George T. Gibbons: Named Washington, D.C., representative of Astropower, Inc., subsidiary of Douglas Aircraft Co., Inc.

William D. Paxson: Appointed vice-president of the General Instrument Corp.'s Radio Receptor Div., Hicksville, N.Y.

Alton D. Anderson: Director of Research for the Technological Center, Cook Electric Co., Morton Grove, Ill., elected vice president of the company.

Col. Robert E. Wilson (USA Ret.): Appointed manager, proposals, of HRB-Singer, Inc., State College, Pa.

Raymond W. Fink: Appointed director of quality controls of Avco Corp.'s Electronics and Ordnance Div., Evendale, Ohio.

Michael J. Welther: Appointed vice president-engineering for Airtek Dynamics, Inc., Compton, Calif.

Robert T. Vaughn: Appointed general manager, equipment operations, Lansdale Div., Philco Corp., Philadelphia.

Gerald Stolar: Named chief engineer for the newly reorganized engineering department of Weston Instruments Div., Daystrom, Inc., Newark, N.J. **Robert Lender** named chief engineer-aerospace.

George Field: Appointed vice president in charge of nondestructive testing operations for Automation Industries, Inc., Torrance, Calif.

George Perrault, Jr.: Named executive vice president of the E. W. Bliss Co., Canton, Ohio.

Walter E. Peek: Named vice president-sales, at Centralab, the Electronics Div. of Globe-Union, Inc., Milwaukee.

Dr. Robert N. Noyce: Elected a vice president of Fairchild Camera and Instrument Corp., Syosset, N.Y.

S. K. Ashby: Appointed manager, product planning, Sierra Electronic Div. of Philco Corp., Menlo Park, Calif.

James J. Tesik: Appointed manager of the quality engineering division of Lockheed Electronics Co., Plainfield, N.J.

Herbert M. Wittmeyer: Appointed director of quality assurance and reliability for the Huck Manufacturing Co., Detroit.

Ernest P. Jacobi: Former West Coast operations manager for Chrysler Missile Div., named vice president and general manager of El-Tek, Inc., Los Angeles.

W. D. Mitchell: Appointed engineering manager of Continental Electronics Mfg. Co., Dallas.

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James L. Murray: Appointed vice president-military sales of the Douglas Aircraft Div., Santa Monica, Calif.

Dr. Carroll L. Zimmerman: Joined Douglas Missile and Space Systems Div., Santa Monica, Calif., as assistant to vice president-director of product development.

Ronald B. Smith: Senior vice president of the M. W. Kellogg Co., New York, named to serve as 1963-64 president of ASME.

Henry F. McKenny: Appointed general manager of Chrysler Corp.'s Missile Div., Detroit.

Emil R. Borgers: Named manager of programing, Scientific Data Systems, Inc., Santa Monica, Calif.

Frank N. Kirby: Appointed Riverdale, N.Y., plant manager for ACF Electronics, a division of ACF Industries.

Dr. James F. Reagan: Named director of engineering, Aircraft and Missile Research and Development, at North American Aviation's Columbus, Ohio, division.

L. A. Wood: Appointed manager of material for General Dynamics/Electronics-San Diego.

Dr. Robert S. Carlson: Joined Ford Motor Co.'s Aeronutronic Div. as director of Space and Weapon Systems, Newport Beach, Calif. **Herbert L. Karsch** appointed manager of Fabrication, Assembly and Checkout.

E. Keith Burnett: Promoted to general manager of the Aerospace Div. of Aeronca Manufacturing Corp., Middletown, Ohio.

Billy R. Bryant: Elected president and treasurer of Garlock of California, aircraft and missile division of Garlock, Inc., Palmyra, N.Y.

Gerald J. Lynch: Named president and chief executive officer of Menasco Manufacturing Co., Los Angeles.

C. L. Constantinides: Appointed director of contracts at the Aircraft-Missiles Div. of Fairchild Stratos, Hagerstown, Md., and also assistant secretary of the corporation.

Maj. Gen. John K. Hester: Appointed assistant vice chief of staff of the Air Force, effective August 1.

Imre Farkass: Promoted to vice president of Ilikon Corp., Natick, Mass.

Donald H. Furth: Appointed director of programming of International Business Machines Corp., New York.

W. C. Holmes: Named president of Fabtron Co., Redwood City, Calif.

Andrew F. Haiduck: Named president of Astronics Div. of Lear Siegler, Inc., Santa Monica, Calif.



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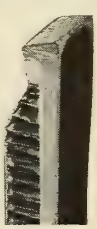
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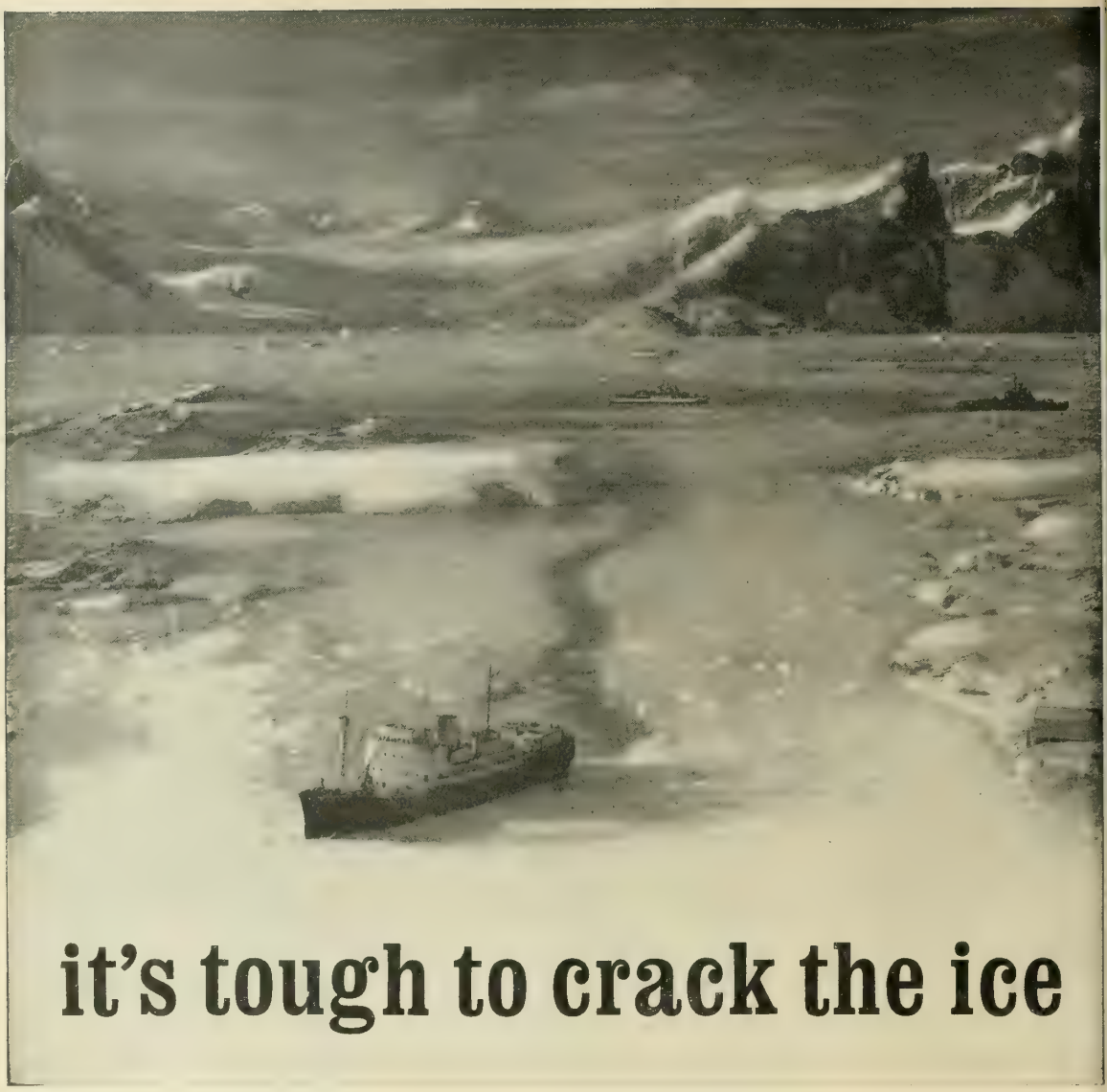
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JULY

Institute in Technical and Industrial Communications, Colorado State University, Fort Collins, July 9-13.

Twelfth General Assembly, NATO Advisory Group for Aeronautical Research and Development, Paris, France, July 12-13.

Technical Report Writing for Engineers and Scientists, UCLA, Los Angeles, July 16-20.

American Rocket Society, Lunar Missions Meeting, Pick-Carter and Statler Hilton Hotels, Cleveland, July 17-19.

Rochester Conference on Data Acquisition and Processing in Biology and Medicine, Whipple Auditorium, University of Rochester Medical Center, Rochester, New York, July 17-18.

Mathematical Aspects of Celestial Mechanics, sponsored by AFOSR/SRMA, Yale University, New Haven, July 23-Aug. 3.

PERT (Program Evaluation and Review Technique) and CPM (Critical Path Method) Seminars, ITT Data Processing Center, Paramus, N.J., July 30-Aug. 1.

AUGUST

Engineering Foundation's Engineering Research Conference on Composite Materials, Tilton School, Tilton, N.H., Aug. 1-3.

Society of Photographic Instrumentation Engineers, Seventh Annual Symposium, Statler Hilton Hotel, New York City, Aug. 6-10.

Institute of the Aerospace Sciences, Man-Machine Competition, Olympic Hotel, Seattle, Aug. 10-11.

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Curiouser and Curiouser

EVERYONE IS FAMILIAR with the story of the blind men who examined an elephant and then gave wildly varying descriptions of the beast.

We are beginning to suspect that someone in the Administration has hired a similar study group to report on the nature of the nation's defense industry. Certainly, the image of the industry possessed by a number of Administration deep-thinkers bears little resemblance to reality.

The most recent case in point is the remarkable testimony before Congress by budget director David E. Bell, who also is a key White House confidant.

It is no secret that a considerable discrepancy exists between government and industry salaries. This indeed is one of the tactic reasons for the formation of such non-profit organizations as Aerospace Corp., and the Institute for Defense Analysis.

Mr. Bell has come up with a wonderful idea for eliminating this discrepancy. It is a method so simple and easy to carry out that it is amazing no one has thought of it before. The government will put a ceiling on salaries paid to top executives and engineers of firms holding government defense contracts.

Voilà, the discrepancy disappears!

"This is a complex and difficult problem which we expect will require a considerable effort," Bell conceded.

That background noise you hear is the sound of companies scrambling to get out of the missile/space business.

The budget director suggested that a top limit of $25,000 would be reasonable for salaries in research and development firms which are awarded contracts in non-competitive bidding. The ceiling would be set by administrative order as part of the contract.

"We have already begun preliminary work within the bureau on the means of establishing controls over salaries and related benefits for contractors where competitive bidding does not prevail," Bell told the House Military Operations Subcommittee.

Any effort to evade the restrictions by such nefarious routes as fringe benefits, expense accounts or stock options would be blocked by the regulations now being drafted by the Budget Bureau.

While this would apply to non-competitive contracts, it is easy to foresee the next step—which would apply the same restriction to all defense contracts.

"We think the government should place a limit on salaries it would reimburse a contractor for," Bell stated flatly. Presumably, a company could augment the government-approved salaries out of profits—if profits still are to be permitted.

It is not surprising that a company such as General Electric makes a deliberate effort to restrict its defense business to 25% of its total effort, preferring to depend upon the commercial market where it is not subject to such delightful reasoning.

But what of a firm such as North American Aviation, which depends almost solely upon government contracts and which makes a major contribution to the nation's missile/space effort? It usually is permitted a profit margin of up to seven or eight percent, about half of which must be returned in taxes. It would face a choice of putting the firm in the hands of $25,000-a-year executives or making up the difference out of its already narrow profit margin.

This prospect does not particularly disturb Bell. He conceded under committee questioning that many firms which depend heavily on government business would have no alternative but to accept such contracts or "fold up shop."

At a time when the Administration is being accused of a "business-be-damned" attitude this will do little to increase the confidence of the business community. It is such a blatant slap in the face that it is frightening. The surprising thing is that there has been so little outcry over it. Perhaps the nation's businessmen are still numb with shock from the stock market slump.

IF YOU THINK that perhaps only a handful of executives and top engineers are affected, the Budget Bureau's own figures might be of interest. These show that over 75% of all executives of major private firms carrying out research and development for the government are paid over $25,000. Such a salary ceiling would affect roughly half of the technical specialists and engineers, to say nothing of its effect on salary scales all down the line.

At a time when all of the nation's industrial and scientific talent is sorely needed on government projects to maintain our competitive edge in the race with the Soviet Union, the Administration seems to be carrying out an almost deliberate program of discouragement. This does not make sense.

There seems to be little comprehension in government of the radical changes which have taken place in the defense industry. Missile/space firms increasingly are funding their own R&D facilities. The day of government-furnished plants is on the decline. With this need for increasing spending on R&D has come a decline in the long production runs which previously provided the monetary rewards for company-funded programs. The missile/space business today is heavily an R&D business.

Yet this change in character has not met a corresponding realization in government. The opposite seems true. The proclamations of budget director Bell fill one with wonderment.

Washington indeed is getting curiouser and curiouser.

William J. Coughlin

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VA [illegible]	[illegible]	5	350	600	50	PPM	Grid
VA [illegible]	[illegible]	25	150	35	35	PPM	Grid
VA [illegible]	[illegible]	[illegible]	200	30	40	PPM	Grid
[illegible]	[illegible]	[illegible]	[illegible]	10	30	PPM	Grid
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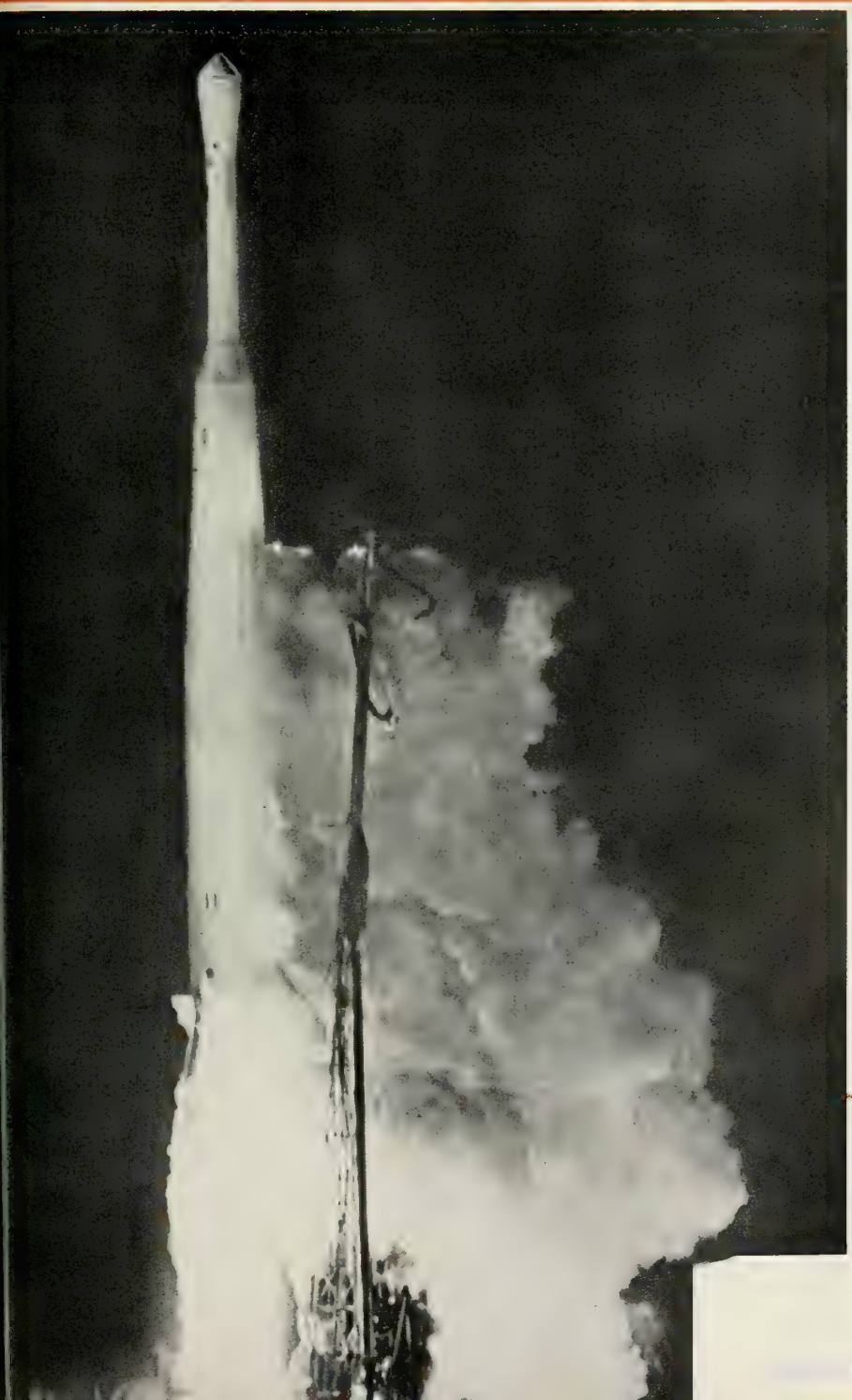
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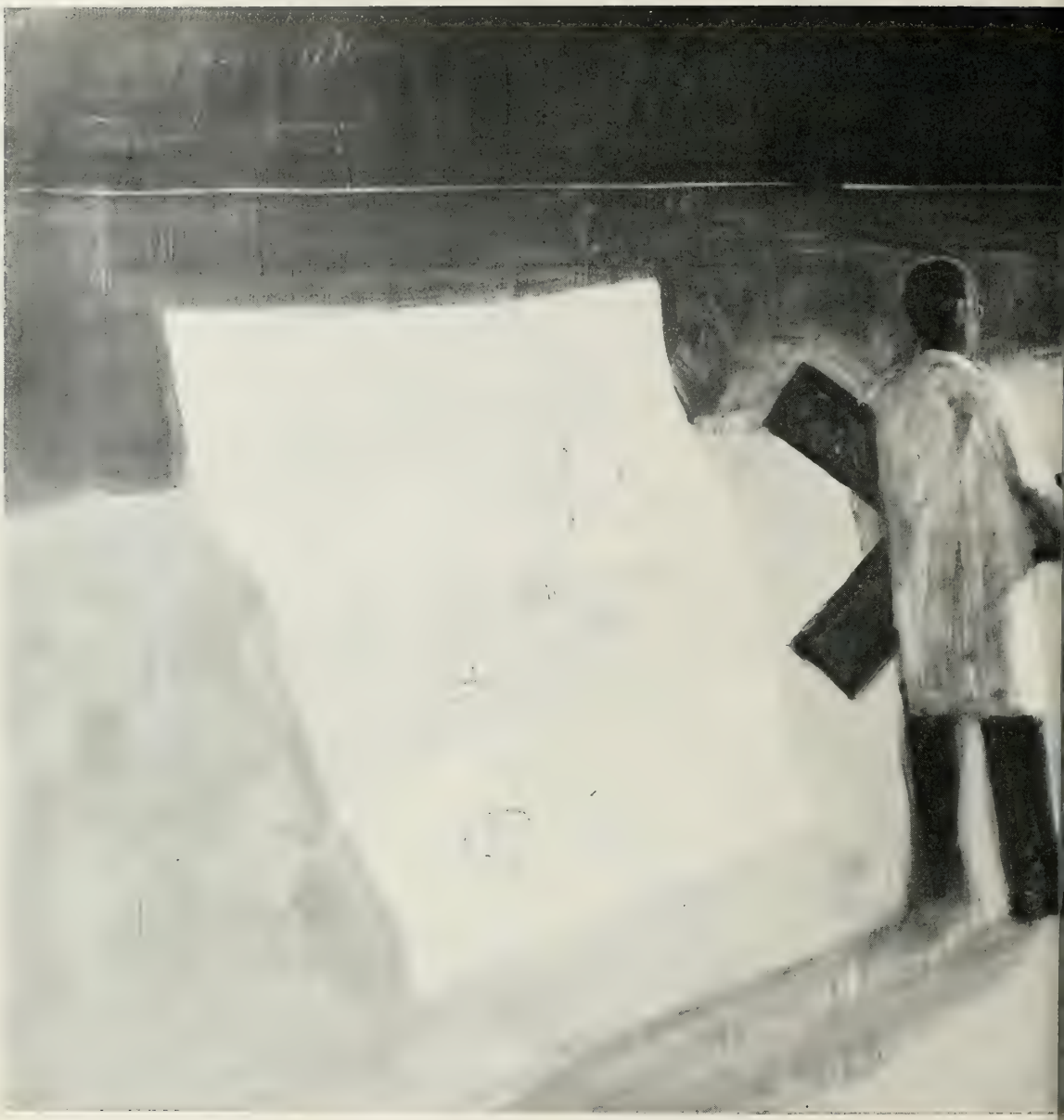


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For now the aerospace industry is called upon to engineer space ships that w travel thousands of miles from earth and return. It is called upon to develop rock engines with the power of a million automobiles. It is called upon to produce electron equipment that will last thousands of hours... to design antenna systems that ca listen to stars billions of miles away...to produce electricity by nuclear power wi increasing efficiency.



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Information from countless sources, staggering amounts of it. New information that changes from moment to moment, old information that must be retrieved from storage in seconds. Information of world importance. This is what command decisions are based on: This is what a new science-technology must cope with to help make command decisions possible. The science-technology of which we speak involves the development of far-reaching man-machine systems to provide information processing assistance for military and government leaders. The needs of this field have created a number of new positions at System Development Corporation. Our scientists, engineers and computer programmers applied this science-technology to help develop SAGE. We now apply it to our work on the SAC Control System and other command and control systems being developed. At SDC, our staff participates in key phases of system development; analysis, synthesis, computer instruction, system training and evaluation. Human Factors Scientists, Operations Research Scientists, Engineers and Computer Programmers interested in joining this expanding new field are invited to write Dr. H. L. Best, SDC, 2433 Colorado Ave., Santa Monica, Calif. Positions are open at SDC facilities in Santa Monica; Washington, D.C.; Lexington, Mass.; and Paramus, N.J. "An equal opportunity employer."

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THE WEEKLY OF SPACE SYSTEMS ENGINEERING

missiles and rockets

Volume 11, Number 3 July 16, 1962

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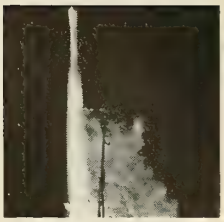
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THE COVER

AT&T's Telstar active communications satellite rises triumphantly from Cape Canaveral on its Thor-Delta booster. The sweeping success of the shot may mean no second launch will be needed. *See p. 13.*



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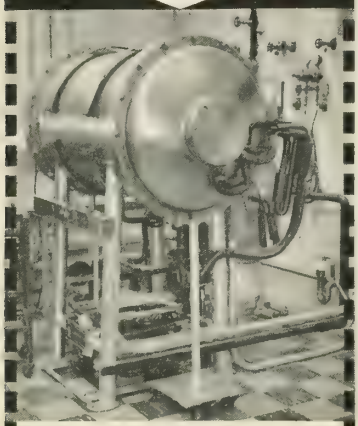
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—letters—

The Urge to Merge

To the Editor:

Since the Dawn of the Space Age, in 1957, the scientific community has been plagued with a malignant growth of compound meetingitis. Professional podium-polishers are no longer required to be profound, or even prolific—merely repetitious. At one recent symposium, a 4:00 p.m. survey paper emphasized the time-killing function of multitudinous meetings: "This may be 'old hat' to those of you familiar with the field. But it should provide the uninitiated with a survey of the current state-of-the-art." Combine bewhiskered papers with poorly planned conferences; add a dash of tiresome tours, and the amount of waste heat radiated to deep space in the form of lost manpower would eclipse the cost of Medicare.

The American Rocketeers and Aerospace Scientists are perched precariously on the verge of a merger, and there are many who deplore the imminent dangers of loss of identity, increase in dues, top-heavy organization, etc. If such an integration can indeed effect a partial check on the mushrooming growth of marginal meetings, the urge to merge should ablate the potential advantages to insignificance.

C. C. Miesse
Westinghouse Astronuclear Lab
Sr. Member, ARS

Overorganization

To the Editor:

Capt. Frank V. Martin makes a very good point ("Dividing the Blame," Letters, M/R, June 18, p. 6), but I think his suggestion (that scientists and engineers responsible for equipment malfunctions in astronautical launchings be identified by name) runs afoul of some matters of high policy that we are not supposed to question.

Joe Doakes, the inadequate engineer who designed parts of the *Aurora 7* system that weren't safe, is in no position to be responsible even if he wants to be. If he finds an error and wants to fix it, there is no one he can tell about it except his boss—and chances are that the boss is occupied with time and money schedules and won't listen. If Joe tells someone outside the organization that employs him, he is liable to get fired. And if Joe goofs and his boss doesn't happen to catch it, the error is in there for keeps. Joe is a full-time employee of an organization, and has to act as such.

My recollection (I am not a lawyer) is this: 1. A court has held that damages caused by engineering errors in a manufactured product are the fault of the corporation, not the individual who made the mistake; 2. Government contracting regulations require that all engineering by contractors be performed by full-time employees of the contractor.

Thus the people who actually design and develop air and spacecraft are not in



we don't know ANYTHING

about making pianos zithers or horse collars

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when it comes to fabricating rocket engines, missile hardware, nose cones, nozzles, plastic laminates, ceramics, plastic extruded pipe, igniter units, these are things we *DO* know about and we make them all with T.L.C.*

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a position to exercise their technical judgment and skill independently. They are Organization Men first, as Government regulations require, and there is no way in which an independent outside investigation of the safety and reliability of a design can be made. Such investigations are in practice made by still other full-time employees of the same organization—reliability groups, value engineering groups, and the like. This sort of self-policing has not been an outstanding success, yet no one seems to make the obvious suggestion: self-policing is inherently contradictory, and engineers and scientists cannot do their best work so long as they are required to divide their loyalties in this organization-happy society.

(Name Withheld on Request)
Pasadena, Calif.

To the Editor:

As a member of the fraternity of men who fly, I wholeheartedly support and applaud Capt. Martin's letter.

In Mr. Martin's own words, "If you haven't been there, fellows, don't knock those who have." Amen, Amen.

J. J. Linfor
Sacramento, Calif.

Underclassed Technicians

To the Editor:

Thanks and well done is what I offer William L. Timmons on his letter to the editor ("Engineering Equivalency," M/R, July 2, p. 6). He expressed well the thoughts of many good, experienced and underclassed technicians. People like John and me can see only a dim tomorrow, but we will continue to increase our job efficiency, take college courses and pursue other means of obtaining technical information. Thus, we can at least satisfy our own ambition while hoping for engineering recognition or a future break away to something better.

Edward H. Pasko
Santa Maria, Calif.

Boeing and Saturn

To the Editor:

The article in your May 21 issue on The Boeing Company's effort in connection with the *Saturn* program ("Boeing Building 25 S-1C Boosters," p. 54) was read with interest. The article provides accurate information about the *Saturn* Branch Materiel and Planning Organization and its procurement policy, but it fails to tell the full story.

There are hundreds of engineers working under my direction and in cooperation with Marshall Space Flight Center engineers on the booster design and test problems in an effort to accomplish this portion of the job as expeditiously as possible so that the production program which your article describes can get under way.

Incidentally, the use of my photograph on the lead page of a non-bylined article implied that I was the source of the information contained in the article, creating the impression that I viewed the role of The Boeing Company in the *Saturn* program as primarily a production assignment. This surprised our customer, NASA. It surprised the engineers working under my direction on booster design and test problems, and it comes as a surprise to me.

George H. Stoner
General Manager
Saturn Booster Branch
Aero-Space Division
The Boeing Company
Seattle

It surprises us, too. No such implication was intended.—Ed.

Component, Not Subsidiary

To the Editor:

In your July 2 issue, you indicated in THE COUNTDOWN that the Bristol Aeroplane Company was a subsidiary of the British Aircraft Corporation. This is not so. The Bristol Aeroplane Company is, in fact, one of the Principal Companies owning 20% of British Aircraft Corporation.

D. Maitland
British Aircraft Corp. Ltd.
London

Short Bros. Gyros

To the Editor:

Your article on cordite-driven gyros ("Gas Gyro Tested for Use in Five Weapons," M/R, May 28, p. 26) was read with great interest and some surprise.

Whilst Lear are undoubtedly making new and interesting advances in this field, some of the "pioneering" claims need to be straightened out. In particular, you may be interested to learn that cordite-driven gyros designed and manufactured by Short Brothers and Harland Ltd., of Belfast, Northern Ireland, were flown in missiles as long ago as May, 1959. Since that time almost 200 have been flight-tested without a single failure being recorded. These have included both displacement and rate gyros.

It is also interesting to note that whilst the performance of the Short's design of displacement gyro is similar to that claimed for the Lear Type 1091, its weight is only half that of the Lear instrument. The basic difference between the two designs is the use of reaction jets in the Short design and an impulse turbine in the Lear arrangement.

Further recent developments by Shorts have resulted in yet improved performance in a still further miniaturised design.

P. F. Foreman
Chief Engineer, G.W.
Precision Engineering Division
Short Brothers & Harland Ltd.
Belfast

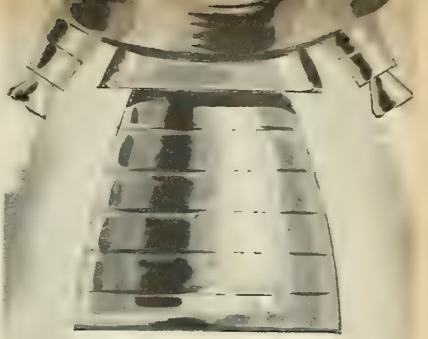
What the Country Needs

To the Editor:

We need more patriotic men like MacArthur and Walker, even if Mr. Rinehart S. Potts (Letters, M/R, July 2) doesn't think so. Those who think the country was made for them are the fuzzy-minded state-liberals.

Fred Jellison Jr.
Boston

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The Countdown

WASHINGTON

First One-Day Mercury Shot Slips

First one-day manned mission of Project *Mercury* now is off until next summer. Four such 18-orbit missions in the modified *Mercury* capsule are on the schedule. It is doubtful, however, that more than two will be made.

No West Coast NASA Ban

Industry reports that NASA has ruled against award of the two-man lunar shuttle vehicle contract to any West Coast firm are denied by the space agency. Proposals will be asked from all areas of the country, according to NASA officials. Despite this, contract is expected to go to an East Coast company.

Nuclear Upper Stage for Moon Trips?

A nuclear upper stage is not expected to be operational until 1970-71, some four years after its scheduled 1966-67 flight test period. That's the prediction from a top propulsion expert at NASA. He says one of its best uses may be as a ferry vehicle from Earth orbit to lunar orbit.

Atlas F Going Operational

First *Atlas F* facility is scheduled for turn-over to Strategic Air Command at Schilling AFB, Kan., in mid-August. Initial training unit at Vandenberg AFB, Calif., already has been accepted by SAC.

Monolithic Big Solids Winning Favor

Top-level government thinking seems to be trending toward a monolithic, rather than segmented, approach for big solids. Transportation problems, it is felt, can be solved. Industry is pushing hard for a decision on the 260-in. solid booster. "We can't wait to see what happens with the 120-in. program," says one industry official. "By then, it will be too late."

NASA Programs Are Sterile

NASA is sticking fast to its sterilization standards for any equipment planned for lunar or other planetary landings. One relatively small component recently had to be "baked" three times at 145°C for 36 hrs. to qualify for a space mission.

Long-Range Snooping by Jezebel

Navy's Jezebel airborne passive ASW detection system has picked up signals from sources as far as 1000 mi. away under unusual conditions. Normal range is considerably less.

Atomic Energy Commission Will Go

President Kennedy is in agreement with Atomic Energy Commission recommendations that the five-man commission be abolished and replaced with a single administrator. This means AEC's portion of the nuclear space program should be under a single manager before the end of next year. Congressional action will be required.

Army Says No Marshall Missile

Published reports that *Missile B* is to be named the *Marshall* are denied by the Army. Although a name has yet to be chosen, it definitely will not be *Marshall,* according to spokesmen.

INDUSTRY

Philco-Aeronutronic Cooperation?

Despite reports to the contrary (M/R, June 25, p. 9), a merger of activities of Ford Motor Co.'s Aeronutronic division and the Western Development Laboratories of Ford-held Philco Corp. seems likely. A recent company analysis of functions and capabilities of the two groups indicated they would complement each other with little duplication.

ComSat Scheduled for Oscar

Following launch of *Oscar II* on June 1, next shot in the Project *Oscar* amateur space communication program will attempt to orbit an active-repeater communications satellite late this year. The 15-lb. satellite and transmitter are now being built. Defense Dept. approval is being sought for a piggyback ride aboard an Air Force satellite. Builder is the Oscar Assn., a group of Northern California employees of aerospace and electronics firms.

INTERNATIONAL

British Need New Missile

British Aircraft Corp.'s TSR.2 strike aircraft may have to be armed with a U.S. air-to-surface missile. No suitable British weapon is available. Work on *Pandora,* the British rocket intended for TSR.2, was halted two years ago.

Sud-Aviation at Work on ALBM

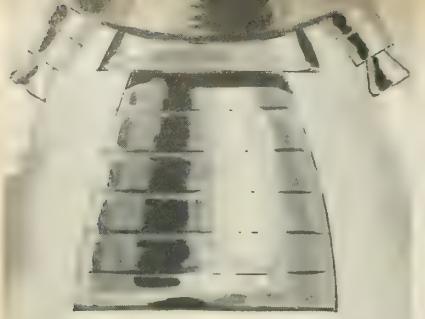
The French government has contracted with Sud-Aviation for feasibility studies on an air-to-ground ballistic missile system. Launch vehicle would be a supersonic platform derived from the Super-Caravelle transport.

New French Antitank Missiles

Nord-Aviation is developing a new generation of antitank missiles under two government research contracts. Production of *SS-11* and *Entac* missiles, meanwhile, is continuing at the Bourges plant. Nord also holds a research contract for a new ground-to-air missile.

NATO Missiles to Use Woomera

The Australian government has agreed to use of the Woomera range for testing of NATO missiles. Government approval will be required for testing of each new weapon.



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CHEMICALS DIVISION

The Missile/Space Week

Slayton Assigned New Duties

Astronaut Donald K. Slayton has been assigned new operational and planning duties within the U.S. manned space flight program, NASA announced last week.

Robert K. Gilruth, Director of the Manned Spacecraft Center, announced the assignment after a thorough medical examination and analysis of the astronaut's heart murmur—known as atrial fibrillation. The conclusion of the examination, he said, was that the condition was such that Slayton could not be recommended for the one-day *Mercury* flights.

Slayton, the announcement said, will work at the Houston Manned Spacecraft Center on the *Mercury, Gemini* and *Apollo* programs. He will continue in the astronaut program, the announcement said, and his physical condition will be monitored on a continuous basis.

Shots of the Week

Telstar, AT&T's active-repeater communications satellite, was successfully launched from Cape Canaveral on July 10 by a *Thor-Delta* space booster (see p. 13).

Expected life of the 34.5-in., 170-lb. sphere is two years. Its orbit has an apogee of 3502 mi., a perigee of 593 mi., a period of 158 minutes and an inclination to the equator of 44.7 degrees.

• After two failures and four postponements, the U.S. on July 8 detonated a nuclear device of more than one megaton over the Pacific, using a *Thor* booster to carry the thermonuclear device to an altitude of 200 miles before detonation.

Part of the current U.S. nuclear tests, the high-altitude weapons-effects experiment caused a temporary communications blackout of about 20 minutes—much shorter than the 16-32 hours predicted—and caused sharp changes in the strength and direction of the Earth's magnetic field.

Two more high-altitude tests are planned in the current series.

• *Titan II,* the AF's storable-fueled ICBM, was successfully launched from Cape Canaveral July 11 on a 5000-mi. flight down the Atlantic Missile Range.

In its third flight test, the 103-ft. Martin missile confirmed the basic integrity of its design and its subsystems. Test objectives also included a test of the missile's accuracy, as well as the environmental conditions of its nose cone during re-entry.

DOD Moves To Save $3 Billion

By improving management and procurement techniques within the Defense Department, Secretary of Defense Robert S. McNamara estimates that he can save $3 billion in defense costs over the next five years.

In a memorandum on "Defense Department Cost Reduction Program," submitted last week to President Kennedy, the Defense Secretary estimated that logistics costs can be cut by "an estimated $750 million in Fiscal Year 1963."

These reductions, McNamara said, are being achieved in three ways: (1) Buying only what we need to achieve balanced readiness; (2) Buying at the lowest sound price; (3) Reducing operating costs through integration and standardization.

Under the first category, McNamara cited savings of $150 million by re-evaluating spare part inventory levels, $225 million by transfer of excess stocks between departments and $10 million through more efficient merchandising of surplus stocks.

Back-bone of the "buying what we need" program, however, is the major drive being initiated by each of the military departments on cost reduction through "value engineering." Essentially a program to reduce over-specifying, or "gold-plating," components for weapons systems without risking their effectiveness, the program has already saved some $64 million within the Air Force and Navy alone. Annual savings through "value engineering", McNamara said, have been put at $100 million.

Turning to the second point, "buying at the lowest sound price," the emphasis, he said, will be placed on seeking greater price competition in procurement.

Citing poor advance procurement planning for past non-competitive purchases, the Secretary said that directives have been issued requiring price competition "wherever practicable" with sole-source procurement authorized "only after rigid review."

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In the past 12 months, DOD converted $650 million in procurement from sole-source to competitive contracts, resulting in a "potential savings" of $160 million. The DOD goal over the next five years, McNamara said, is triple this amount.

Fixed-price and incentive contracts will be utilized wherever possible under the cost reduction program. In fact, the long-term DOD goal is to reduce cost-plus-fixed-fee contracts by $6 billion with potential savings of $600 million.

Reduction of costs through integration and standardization—the third major area discussed by the Secretary—is directed at elimination of unnecessary overhead at bases and installations, standardization of procurement and logistics paperwork and more efficient management of the supply and service activities.

Over the next five years, McNamara expects to realize savings of more than a billion dollars. During FY '63, he estimates that some $437 million will be saved—chiefly through closing excess bases, reducing clerical help in procurement areas and actions of the Defense Supply Agency.

President Kennedy hailed McNamara's report as "of the greatest importance."

AF Denies Titan-II Slippage

Reports that the *Titan II* missile base construction program at Davis-Monthan AFB, Ariz., faces a major cost over-run and slippage in the completion date were strongly denied by AF officials last week.

Admitting that some phases of construction were behind schedule, they claimed nevertheless that the overall project is "ahead of schedule." All construction is expected to be completed by December. However, three silos originally planned for completion June 12 have been delayed "due to changes or modifications in construction."

Although the cost of the base will exceed the original $93-million estimate, the AF said, it "will not in any way approach a reported $360 million."

Wiesner Heads Science Office

Dr. Jerome B. Wiesner, the President's Science advisor, has been nominated to be Director of the new Office of Science and Technology. President Kennedy sent the not-unexpected appointment to the Senate for confirmation last week.

The office was created by executive order in April and went into operation last month when Congress failed to object to it.

Senate Approves NASA Bill

By voice vote last week, the Senate approved a $3,820,515,250 NASA authorization bill—thus restoring $45,853,250 of the $116,114,000 cut from the authorization measure by the House. The Senate also added $32,000,000 for the 14,800-acre, second-phase addition of land at Cape Canaveral. The House did not consider this particular item.

The bill was immediately earmarked for a joint Senate-House conference committee for action to resolve the differences between the two measures.

Before the final vote, the Senate defeated by roll-call votes two amendments by Sen. William Proxmire (D-Wis.) that would have required NASA to make the maximum possible use of advertised bids in the space program and would have set up a Space Manpower Commission appointed by the president. The commission, Proxmire said, would conduct "a thorough study" of the impact of the Space program on scientific and educational resources. The amendments were defeated 73-22 and 83-12.

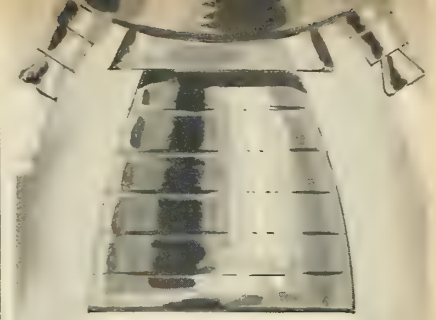
House cuts sustained by the Senate were; $10 million for *Prospector* and $60,760,750 for construction of a *Nova* launch complex at Cape Canaveral.

The Senate restored House cuts of $1 million for *Mercury* program, $8,758,250 for the scientific satellite program, $13,558,000 for lunar and planetary programs and $22 million for construction of facilities. The Senate also doubled the $500,000 House addition for high-energy fuel facilities and earmarked the funds for use at NASA's Lewis Center.

Space Economy Hearings Set

The House Space Committee has set aside the week of July 23 for hearings on ways in which economies can be achieved in the space program. A committee staffer said NASA officials will be asked to indicate the extent of savings possible through such things as simplified countdown procedures, development of recoverable boosters, and increased use of automated devices. The move is said to be the response of Chairman George Miller (D-Calif.) to reservations expressed by ranking members of the House Rules Committee and others in the House when this year's $3.7 billion NASA authorization bill was reported by the Space Committee.

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Another $44 million sought . . .

MIDAS Faces Re-orientation

Reportedly snagged by sensor troubles, AF system is being drastically simplified

by James Trainor

MIDAS—the Air Force's highly touted *Missile Defense Alarm System*—is in serious development trouble and is currently undergoing a DOD-directed re-orientation and simplification to give it an early minimum operational capability.

Although specific details of the development troubles are not available to the public because of the curtain of secrecy imposed by DOD Directive S.5200.13, it is understood that the problem is mainly due to the failure of the system's infrared sensors to meet performance expectations.

Reliable sources report that the sensors have been unable to distinguish the infrared radiations of a missile during its boost phase from intense natural radiations, such as sunlight reflected from cloud cover. The IR detector system is more acceptable, however, during periods of darkness when the light contrast is at a minimum.

• **Program re-oriented** — While it lacks the fanfare attending the recent "re-orientation" of the *Advent* communications satellite program, the revamping of the *MIDAS* program is no less severe.

Originally scheduled to become operational in mid-1962, *MIDAS* is now to be "pursued as a research and development program with no provision for an operational system." Under the now-scrapped program, the early warning satellite system would have employed 12-15 spacecraft in precisely controlled, near-circular orbits.

With such a system, the Air Force expected to increase the warning time of a ballistic missile attack from the 15 minutes provided by BMEWS to at least 19 and perhaps 30 minutes.

Under the re-orientation, however, a simplified system "utilizing satellites in random orbits" will be developed.

The "second-look" at *MIDAS* began during the first quarter of this year. By April, the Air Force had submitted a revised development plan to the Director of Defense Research & Engineering, Dr. Harold Brown.

Although in general agreement with the AF plan, Brown has withheld full funding for the program until the Air Force revises the plan to include the possibilities of "earlier flight-testing of improved payloads." The study was to have been submitted to DDR&E by the latter part of June.

Admitting that the original *MIDAS* approach was "very complex", Air Force officials now say they "have concluded that the most effective *MIDAS* system can be accomplished by simplifying the approach—the technical approach—to the *MIDAS* vehicle, itself."

Through this simplified approach, AF officials say, "we feel we will arrive sooner at an effective early warning system."

But they add that although an estimated $100 million is slated for the early warning system in FY '63, "an additional $44 million is required to adequately support the *MIDAS* development program. . . ."

• **What is not said** — The early warning satellite program has been a high-priority system in the Defense Department since 1959. In November of that year, *MIDAS* was transferred from the Advanced Research Projects Agency (ARPA) to the Air Force. It now is a development program in the AFSC's Space Systems Division.

Under this management structure and the technical assistance of Aerospace Corp., the Air Force will have spent over $400 million on the *MIDAS* program by the end of FY '63. In addition to the $100 million programed for this fiscal year, *MIDAS* received $190 million in FY '62 ($60 million of this an add-on "to keep the program on schedule") and $109.4 million in FY '61. Of the $361.4 million spent on *Discoverer, Samos* and *MIDAS* in FY '59 and prior, probably less than $100 million was specifically earmarked for *MIDAS*. During that period, however, the pacing factor was the development of the *Agena A* spacecraft to be used in all three programs.

Although it is impossible to estimate how much of this money will have to be written off under the re-oriented program, it will be a large amount.

MIDAS, even more than *Advent*, is a striking example of the cost effects of over-optimistic projections of the future state of the art. This is undoubtedly what Assistant Secretary of Defense for Research and Engineering John H. Rubel had in mind when he told M/R in March that the military services would do well to concentrate on results from projects in being before making demands for more resources.

• **MIDAS flight tests**—Of the five *MIDAS* spacecraft launchings of the last two years, four were successfully injected into orbit. After the failure of *MIDAS I* on Feb. 26, 1960, *MIDAS II* was successfully launched on May 24, 1960, but failed two days after launch when the telemetry data-link transmitting IR-scanner information to the ground malfunctioned.

MIDAS III — weighing approximately 1000 lbs. less than the first two spacecraft—was the first early warning satellite to be injected into a polar orbit. Launched July 12, 1961, it successfully proved the capability of the Lockheed *Agena-B* to place the payload in a near-circular orbit in the proper orientation.

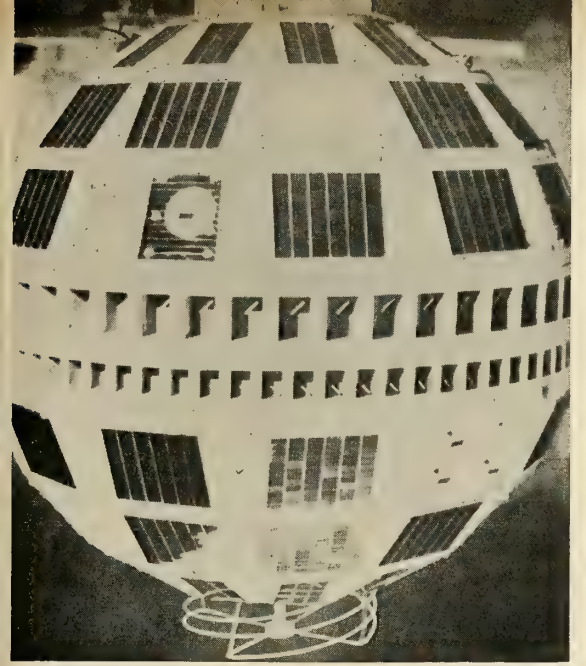
MIDAS IV—launched into a near-circular polar orbit on October 21, 1961—is widely credited with detecting "a *Titan* launch from Cape Canaveral about 90 sec. after liftoff in a test on October 26." Both DOD and AF officials now say that, in fact, the early warning vehicle did not detect the launch.

MIDAS V—the latest early warning spacecraft—was launched from Pt. Arguello, Calif., April 9. However, it fell under the DOD space secrecy directive and no details of the launch are available—except that the orbital data shows the polar orbit is not nearly as circular as those of the *III* & *IV* vehicles.

• **So what now?**—According to official AF sources, once the development plan is approved by DDR&E and the funds are made available to SSD, work will be carried on to develop and test improved sensor systems.

However, before any early warning system will again be approved for operational development, the Air Force will have to demonstrate the effectiveness of the simpler, random-orbit system.

Only then, AF officials say, will they be in a position to go into an operational system with *MIDAS*. ‡





LEFT: *First photo transmitted via Telstar.* **ABOVE:** *Vice President Johnson as he received first telephone call via Telstar. Call was placed by Frederick R. Kappel, AT&T board chairman, from Andover, Maine. Johnson was in Washington.*

Telstar Hailed as Major Advance

Second test launch may prove unnecessary; smoothly launched satellite scores list of unprecedented achievements

FIRST FLIGHT of American Telephone and Telegraph Co.'s *Telstar* satellite has been so successful that the firm may drop plans for a second launch this fall.

An AT&T spokesman said that the second launch of the active communications satellite will be made only "if it promises to add new knowledge."

"That question," he continued, "has not been resolved." He indicated that it will be quite some time before a final decision is made.

Meanwhile, top U. S. space and communications officials hailed the July 10 successful launch of *Telstar* as the first major step leading to a worldwide communications system.

Federal Communications Commission Chairman Newton Minow declared that the satellite "may lead to the development of a worldwide communications network."

Experts estimate that such a system would require approximately 40 of the low-altitude *Telstar*-type satellites to provide total coverage. Another system being considered would employ three high-altitude synchronous satellites at 22,300-mile altitude.

Besides *Telstar,* NASA plans to launch low-altitude *Relay* satellites and the *Echo* passive communications satellite this year as part of the research program leading to an international system.

It is probable that one of the reasons why AT&T may decide not to launch another *Telstar* is the high launch cost—$3 million—which the company paid the space agency.

• **Smooth all the way**—The shot was one of the most successful space flights in U.S. history. There were no holds during the countdown and the satellite went into the nominal orbit required for good transmission. Part of this was attributable to its *Delta* booster, which has chalked up 10 straight successful launches.

The satellite itself chalked up an amazing list of achievements only hours after it was boosted into orbit. These included:

—First transatlantic transmission of live and taped television from the U.S. to France and England by way of an active repeating satellite.

—Transmission of voice conversation between Vice President Lyndon B. Johnson in Washington, D.C., and AT&T's Board Chairman Frederick R. Kappel at the firm's Andover, Maine, antenna facility. The words were sent up to the 34-in. satellite, magnified ten billion times and hurled back to Earth. Observers said that the conversation sounded as if the two were talking from points only a few miles apart.

—Still photographs sent to and received from the satellite.

Telstar's achievements came 15 hours after the 170-lb. satellite was launched from Cape Canaveral at 4:35 a.m. July 10.

Sent aloft atop a *Thor-Delta* rocket, it is now circling the Earth every 156 minutes, swinging in an orbit that takes it from 575 to 3450 miles above the Earth.

At 7:17 p.m.—on its sixth orbit—*Telstar* was picked up by AT&T's giant horn antenna at Andover, Maine. After preliminary tests lasting 16 minutes, the experimental transmissions began.

At 8:06 p.m. Earth Station One, as Andover has been named, stopped "talking" to the satellite. Seven minutes later *Telstar* was again over the horizon and out of "sight."

In its seventh orbit, *Telstar* proved its versatility by receiving and sending back pictures, phone conversations and news stories simultaneously.

The stories were sent by AP and UPI from Andover, via the satellite to Holmdel, N.J., then to the wire services' New York offices. The transmission was by "data speed" equipment which can send 1000 words a minute. The stories were bounced from Maine to New Jersey via space in half a minute. ⌘

In wake of LOR choice . . .

NASA Ready to Seek Bids on 'Bug'

Officials say there's still a chance of later alternate choice of direct flight

by Hal Taylor

NASA WILL SELECT six to 10 firms to submit proposals for the production contract for a two-man lunar excursion vehicle to be awarded in about three months.

D. Brainerd Holmes, director of the space agency's Office of Manned Space Flight, said last week the request for proposals would follow within a week its July 11 announcement of the selection of lunar-orbit rendezvous as the primary method of achieving a manned lunar landing (M/R, June 11, p. 12).

At the same time, NASA officials left the door open for the later selection of an alternate route—a direct flight with a scaled-down two-man *Apollo* spacecraft.

The final decision, NASA Administrator James E. Webb said, would depend upon:

—Whether industry proposals on a lunar excursion vehicle come within NASA's cost and time estimates.

—Further study to determine whether the cost and time of the direct two-man mission with an *Advanced Saturn* launch vehicle will compare favorably with comparable lunar-orbit rendezvous (LOR) estimates. The study also involves an appraisal of Earth-orbit rendezvous and the two-man *Apollo* spacecraft.

Other major aspects of the LOR announcement:

• Development of the *Nova* launch vehicle will be deferred for at least two years. Within a few weeks, NASA will select industrial firms to make detailed design and conceptual studies of a beefed-up *Nova* with a possible thrust of up to 21 million lbs. in its first stage. Five firms—Douglas, General Dynamics/Astronautics, Lockheed, Martin and North American—have been requested by NASA to submit proposals for two parallel studies. The magnitude of these studies will be increased sharply to include the question of whether solid or liquid propellants should be used in the first stage, what thrust is needed for long manned interplantary flight, whether new engines should be developed, and the possible uses of nuclear upper stages. Dr. Joseph Shea, Director of Project *Apollo* systems engineering, told M/R that the same firms will probably be considered for the new study contract.

• A two-stage *Saturn C-1B* will be used for early development flights to test the lunar-orbit configuration of *Apollo*. The launch vehicle's first stage will have eight H-1 engines. Its second stage will be composed of one J-2 200,000-lb.-thrust liquid hydrogen engine.

The *Saturn C-1B* will have a payload capability of 32,000 lbs. in Earth orbit.

• NASA will begin an immediate in-depth study of an unnamed lunar logistic vehicle, to determine how such a vehicle could be used to support the lunar exploration program. The craft would supply the two-man lunar excursion vehicle on the lunar surface and provide equipment to extend the exploration time on the Moon. It will also contain equipment for space science studies of the lunar environment.

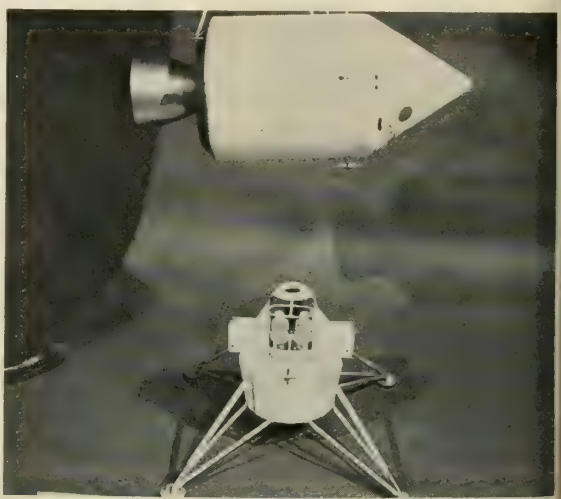
Space agency officials said LOR was selected because it will save up to two years in the lunar landing timetable and is 10 to 15% cheaper than Earth-orbit rendezvous or direct flight with the *Nova* vehicle.

A final decision as to whether LOR or direct flight with the lighter two-man *Apollo* capsule will be employed will be made in about two months. It is apparent, however, that NASA's top leadership now favors LOR—and only tremendous cost savings could change their minds.

As presently envisaged lunar orbit rendezvous would require a single launch of an *Advanced Saturn* boosting a 13-ft.-dia. three-module spacecraft. ⌗



MODEL OF the command/service modules which will orbit the Moon while the excursion module descends to the Moon.



EXCURSION VEHICLE model. The vehicle will take two astronauts to the lunar surface; one remains on C/S module.

Parallel contracts involved . . .

NASA Picks Eight Firms To Study Advanced Projects

Awards cover work on Post-Nova launch vehicles, sea-launched space vehicles; other boosters and space missions

NASA's Marshall Spaceflight Center has selected eight missile/space firms to conduct seven studies of future launch vehicles and space missions.

The studies include:

—*Post-Nova launch vehicles.* Three six-month parallel studies: Douglas $75,000; General Dynamics/Astronautics $85,000; Rand Corp. $86,000. Purpose is a state-of-the-art-review of large rockets which would be available in 1972 or later, to help determine the probable operational lifetime of *Nova,* and to aid in long-range planning of propulsion systems and missions.

Sea-launched space vehicles. A six-month, $130,000 contract to Space Technology Laboratories, with Aerojet-General acting as subcontractor. Investigated will be a feasibility of a sea-launched two-staged vehicle to lift a million pounds into Earth orbit. Called for is a vehicle system definition, facilities requirement, and an indication of technical feasibility and R&D costs of both recoverable and expendable versions.

—*Reusable ground-launched vehicles in the 50-to-100-ton class.* Two six-month contracts: Boeing Aerospace Division, $150,000; North American Space and Information Systems Division, $142,000. Assuming *Saturn C-5* to be the major rocket for orbital launching in the period 1965-1972, the contracts call for (1) determining conditions under which conversion to reusable configuration will be beneficial; (2) defining configurations best suited to succeed the *C-5;* and (3) an outline of interim steps through which technology and techniques for vehicle reuse can be developed in an orderly manner.

—*Solid Saturn C-1.* One six-month $197,000 study award to Lockheed to aid in determining if substantial gains can be achieved in *Saturn C-1* vehicle performance, costs, reliability and other the current booster with a clustered operational considerations by replacing stage of 120-in. solid motors, using a *Saturn C-IVb* second stage. Called for is trajectory and performance analysis, preliminary design and design criteria, and operational analysis of such a rocket.

—*Solid Nova.* A six-month, $139,000 preliminary vehicle design study by Boeing Aerospace Division, continuing a previous solid rocket study. New "task assignment" is to perform preliminary design studies on a *Nova*-class solid-propellant vehicle with detailed design investigation of thrust control systems, vehicle staging, motor clustering and facility requirements.

—*Low acceleration space transport systems.* A $78,000, six-month study by the Rand Corp. to investigate the desirability and attainable characteristics of electrically-propelled space vehicles, assuming a flight period 1967-1980. Electrical power sources and propulsion design are to be covered in the study.

Contracts have been signed with two firms for the study of design concepts of a reusable 10-ton-capacity cargo-passenger space transport which would shuttle between Earth and a 250-mile Earth orbit.

The contract calls for six-month, parallel investigations by the Lockheed California Co., $78,000, and North American Aviation, Inc., $92,000. The object of the studies is to develop design approaches for an economical means for transporting personnel and cargo from Earth to orbit in support of manned space stations, lunar bases and early manned interplanetary flight.

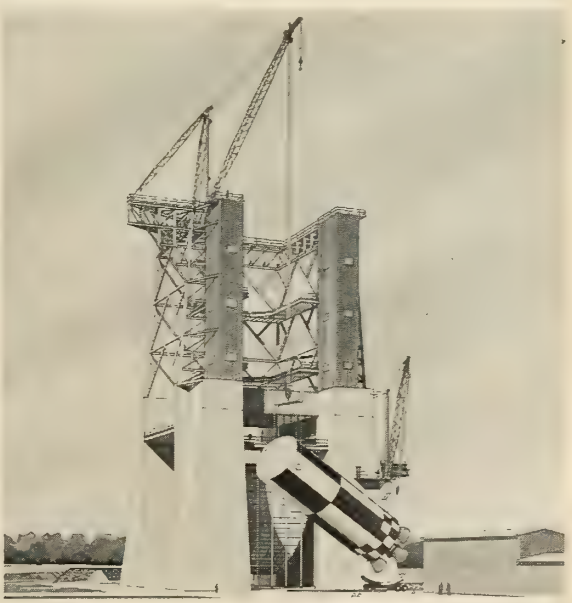
The study assumes such a carrier could be operational about 1970.

The shuttle vehicle would carry either 10 tons of cargo or 10 passengers and a two-man crew to an Earth-orbital rendezvous with an out-bound vehicle, transfer its cargo or passengers and return to Earth's surface to reuse. The carrier would have a minimum service life of 100 roundtrips. These studies will concern vehicle configuration, reliability and safety, costs and development schedule.

The agency also announced award of two contracts for compiling and cataloging space flight data in book form. One six-month $85,000 contract to Lockheed is for a compilation and publishing of information on missions to Mars, Venus and Mercury, including energy and guidance requirements, during the period 1965-1980. The second contract, $150,000 for nine months to the Martin Co., is for compilation of a large body of information on Earth-orbital operations and lunar missions, incorporating material which now exists in several Earth-orbital handbooks. ⌘

Big Stand For Saturn

NASA artist's conception of static test stand for Advanced Saturn. Space agency has already asked for bids.



24 nations taking part . . .

U.S. Maps Plan for 'Quiet Sun Year'

Space agency may launch as many at 31 satellites with main emphasis on solar studies; Goddard Space Flight Center to conduct world magnetic survey

by Heather M. David

NASA WILL LAUNCH about 300 sounding rockets and 12 satellites as part of the U.S. participation in the International Year of the Quiet Sun.

An additional 19 satellites are under consideration as part of the program. The "Year," which officially begins April, 1964, and ends December, 1965, encompasses a solar low period. Its purpose is to coordinate wordwide research into the nature and effects of solar activity during this time.

Countries participating in the IQSY will be: Argentina, Belgium, Canada, Czechoslovakia, Denmark, Finland, France, German Federal Republic, Hungary, India, Ireland, Italy, Japan, Korea, Malagasy Republic, Netherlands, Poland, Republic of South Africa, Spain, Switzerland, Taiwan, United Kingdom, USA and USSR. Australia, Bolivia, Chile, Iran, Yugoslavia, Mexico, New Zealand, Pakistan, Rhodesia, Nyasaland, Rumania and Vietnam also have expressed interest.

Exact terms of Soviet participation have not been laid down, but observers say that it will probably result in separate, secret launchings and measurements, with cooperation in release of data.

• **Eye on Sun**—NASA's prime contribution to IQSY will be in the study of the Sun itself. According to NASA spokesmen, experiments will concentrate on the short wave-length portion of the solar spectrum. In addition, solar radiation in the X- and gamma-ray energy regions will be monitored.

Radiation data obtained during this period will not be available for the *Apollo* program, since *Apollo* shielding plans must be frozen by the end of 1963. However, if unforeseen radiation data are obtained, they will of course be incorporated into the program.

NASA hopes to learn a great deal more about the Van Allen belt during this period, with special attention to establishing whether or not there is a systematic variation of intensity as solar activity wanes. Thus it hopes to understand the origin, lifetime and possible accelerating mechanism of the trapped radiation.

Another goal is to find a means to predict the paths of solar proton beams ejected from the Sun during periods of solar activity. NASA scientists conjecture that direct measurements of the intensity and direction of the magnetic fields in the solar system made at different times may give this means, since these fields are quite sensitive to solar activity.

• **Magnetic mapping** — NASA's Goddard Space Flight Center is responsible for making a world magnetic survey during IQSY. A low-orbit, polar-orbiting satellite will be used. In addition, highly-eccentric-orbit satellites will make measurements of the geomagnetic field from 100 to 300,000 km.

Detailed cloud cover will be made by polar-orbiting, Earth-stabilized spacecraft with TV cameras and infrared radiation sensors. *Arcas*-type meteorological rockets (100 in 1964 and 150 in 1965) will be launched. *Nike-Cajun* rockets with grenades for wind and temperature measurements will also be launched, at the rate of 30 in 1964 and 40 in 1965.

Specific U.S. spacecraft to participate in the IQSY program are: an advanced version of *Orbiting Solar Observatory, Interplanetary Monitoring Probe, Eccentric-Orbiting Geophysical Observatory, Polar-Orbiting Geophysical Observatory, Mariner R, Mariner B, Surveyor* and *Nimbus* (see chart).

• **Possible satellites** — Also under consideration is a *Satellite Ionespheric Monitor*. This craft would be a combination of a topside sounder, direct electron-density measurements, a radio beacon, magnetometer and energetic particle detector, launched into a 2000-kilometer polar-circular orbit in late 1964. NASA says this satellite is needed to sound the ionosphere from altitudes

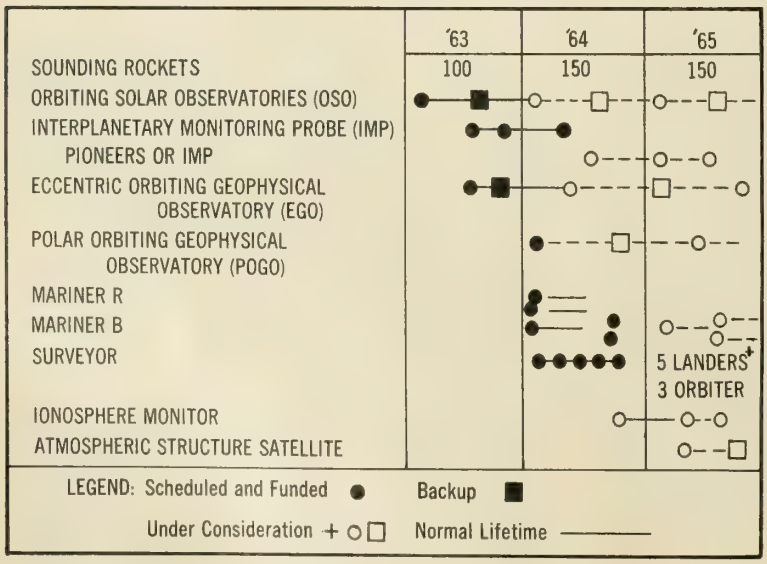


CHART SHOWS how NASA will use variety of spacecraft in its IQSY program.

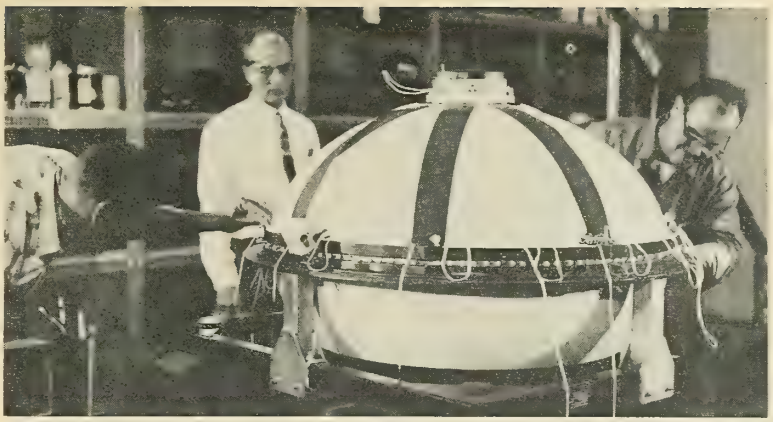
above 2000 kilometers, not possible with the *Polar-Orbiting Geophysical Observatory*.

A *Pioneer* satellite weighing 120 lbs. with a 15-lb. payload also is being considered. This craft would be launched to escape velocity with a modified *Thor-Delta*. It is to have continuous communications, with a data rate varying from 250 bits per second near the Earth to 4 bits per second at 1 au. *Pioneers* may be employed simultaneously with follow-on *IMP's* in 1964-65, or in lieu of the *IMP's*.

In addition, a successor to the *S-6 Atmospheric Structure Satellite* is being investigated for launch in 1965. This will be programed when results of the *Atmospheric Structure Satellite* becomes available.

• **U.S. program**—Other U.S. governmental agencies participating in the program are the National Science Foundation, the Central Radio Propagating Laboratory of the National Bureau of Standards, the U.S. Weather Bureau, the Coast and Geodetic Survey, Naval Research Laboratory, Office of Naval Research, Air Force Cambridge Research Laboratory, Air Force Office of Scientific Research, and the Atomic Energy Commission.

A program of World Days will be held during IQSY, much as it was during the International Geophysical Year. Solar and geophysical data will be rapidly assessed so that Alerts and Special World Intervals can be called when events of interest are occurring. The AGIWARN at Ft. Belvoir, Va., and the North Pacific Radio Warning Service of the National Bureau of Standards will warn for this hemisphere.



Echo Readied for Suborbital Test

TECHNICIANS at Cape Canaveral prepare a 500-lb. spherical canister with Echo III packed inside for a forthcoming suborbital launch. The inflatable passive communications satellite, made of three-ply laminate, will be shot into a trajectory to test inflation. A TV camera will send back a signal to report on the operation.



160-lb. Back Pack For Spaceship Crewmen

THIS self-maneuvering unit (SMU) has been developed for the Air Force by Chance Vought and is now being tested. It will be used by crews outside their vehicles for repairing, servicing or exploratory purposes. It can operate for 4 hrs.

• **Solar activity program** — Optical photographic flare patrols throughout the U.S. will supply the AGIWARN network with solar activity information. This information will be coordinated by World Data Center A for solar activity at the High-Altitude Observatory, and the Solar-Geophysical Group at the Central Radio Propagation Laboratory of the National Bureau of Standards, Boulder Laboratories. The Instituto de Geofisco de Huancayo may also participate, according to preliminary plans.

Solar research programs and specialized magnetic observations will be made by existing basic solar research centers, such as the High-Altitude Observatory, Climax; Sacramento Peak Observatory; and McMath-Hulbert Observatory. Radio astronomers at Harvard College Observatory, Ft. Davis, Tex., plan basic radio measurements of the Sun during the time of minimum.

• **Geomagnetism** — In addition to observatories already operating, a new station now being planned near the Sentinel Mountains may be operating during the period. Sq and equatorial electrojet measurements may be made by instrumentation at several Pacific island locations.

Micropulsation measurements, now being made by Earth current probes, will be made in instrumentation measurements of the aurora and ionosphere.

The *Polar-Orbiting Geophysical Observatory (POGO)*, orbiting at about 500 km, will include magetometers to monitor the magnetic field. Several space probes and another satellite with a highly eccentric orbit will also carry magnetometers.

• **Aurora**—Both synoptic and conjugate point programs are planned for U.S. participation. All-sky camera stations in Alaska will operate, probably with redesigned optics and 35 mm cameras. Some of the IGY cameras may be relocated in the northeastern U.S. to sites of better weather. Visual observer and photometer patrols will continue to operate.

• **Airglow**—Top attention will be paid to the occurrence, morphology and development of the red arcs, along with their relationship to other high-atmosphere phenomena. Automatically-scanning multicolor photometers will continue operating.

• **Cosmic rays**—In addition to satellite measurements, high-counting rate super monitors to supplement the neutron monitor network are being planned. Additional Antarctic stations will be added to the monitor and plastic scintillation meson telescopes at Thule, Greenland, and McMurdo Sound, Antarctica. The Swedish-U.S. IGY experiment of a shipboard neutron monitor traversing the equator will be repeated, along with other shipboard monitors deep in the Southern Hemisphere.

• **Ionospheric physics**—Special IQSY programs are being planned, including high-power radars now under construction to extend radio probing as far out as several Earth radii. NASA has issued a special grant to Dr. Sidney Bowhill of Pennsylvania State University to study the needs of a synoptic study of the lower ionosphere and the type of instruments and rockets which are most suitable. ❖



U.S.S. HUNLEY at sea after launching from Newport News Shipbuilding Co.

Navy Commissions First Tender Built for Polaris

Due at Holy Loch in January, the Hunley boasts huge storage facilities and 52 sub repair shops

THE NAVY has commissioned the first ship especially designed to service *Polaris*-launching submarines.

In effect a floating missile base, the U.S.S. Hunley has a 52-shop repair facility, accommodations for nearly 1400 officers and men, enough stores and spare parts to fill a supply center, and a complete missile and storage area —all crammed into a ship 599 ft. long.

She is scheduled to replace the only other *Polaris* tender, the Proteus, now in service at Holy Loch, Scotland. But it is hard to consider the two ships in the same family. The Proteus is a converted World War II-built sub tender. The Hunley, planned from the start for her *Polaris* support role, is the Navy's largest tender and the first tender built since World War II.

• **80,000 items** — The Hunley will carry three times the stores that an aircraft carrier does and a third more than the Proteus. This stock includes spare parts for the *Polaris* submarines—some 80,000 different line items—and food supplies.

To keep track of all these items the Hunley has 16 machine accountants operating a battery of electronic computers with nine storekeepers keeping track of the stores.

Fifty-two shops in the Hunley can perform almost any work on a *Polaris* sub that a shipyard can—from fabricating metal parts to repairing the most sensitive electronic and optical instruments.

The ship's navigation equipment repair shop, for instance, can repair the intricate inertial navigation devices aboard a *Polaris* sub as well as any yard can. In fact, hooked up in the shop are two complete inertial navigators identical to the three such devices in each *Polaris* sub. In case a rush repair job is needed, one of the Hunley's two sets can be pulled out and hooked up in the sub.

(Ironically, the Hunley can't navigate with her two inertial navigators because she lacks some of the related equipment. However, the tender does have the latest word in conventional shipboard navigation gear.)

• **Nuclear works**—Separated from the rest of the Hunley's repair shops are the ship's nuclear spaces, where repairs can be made on submarine power plants. These spaces include a complete technical library for use by the submariners and a "clean room" complex to sterilize parts going into the sensitive nuclear reactors in the A-subs.

Although spare nuclear cores will not normally be stocked aboard the Hunley, the ship will be able to refuel a nuclear sub. The core can be flown to the tender whereever she may be deployed. However, because of the long life of cores now being installed in A-subs it is expected that replacements by tenders will be few and far between. The Hunley's own engines are diesels.

Deep in the bowels of the Hunley is a huge store of torpedoes similar to that found in other submarine tenders. These are for *Polaris* subs and any other U.S. or Allied undersea craft that may be in need of "fish."

• **The arsenal** — The ship's "big bangs" are amidships. She carries an undisclosed number of *Polaris* missiles which will be used to replace missiles in the submarines which don't check out properly. From time to time missiles in the subs will be "pulled" and taken aboard the tender for extensive examination.

Should the A-subs be ordered to fire their missiles, and the Hunley survive the initial attacks of the war, the tender will be able to reload one sub and possibly give another a few missiles, but she carries nowhere near the 144 *Polaris* missiles in a nine-sub squadron.

To load the missiles into subs the Hunley has a giant 32½-ton capacity hammerhead crane, the only device of its kind on a Navy ship. With this crane, able to rotate 360 degrees, precise positioning of the submarine alongside is not required as is with the Proteus. This is but one of the many time-saving advantages the Hunley boasts over her predecessor.

• **Crew facilities**—In the "motel" business the Hunley can accommodate 30 officers and 270 enlisted men from her brood of submarines while the craft are alongside being serviced and switching their alternating Blue and Gold crews. This is in addition to space for a ship's company of 58 officers and 1023 enlisted men.

• **Schedule**—After loading supplies at the Norfolk Naval Supply Center—a 45-working-day task—the Hunley will go to Guantanamo Bay, Cuba, for a shakedown cruise and training. Then she will return to the Norfolk area for post-shakedown yard work.

In December she will go to Charleston, S.C., to take aboard a load of *Polaris* missiles. She's then expected to head across the Atlantic, arriving at Holy Loch in early January. There she'll relieve the Proteus and take aboard the staff of Commander Submarine Squadron 14.

Plans for the Proteus have not yet been announced; however, it appears certain she'll return to the United States for a much-needed yard period and modernization.

A sistership to the Hunley—the Holland—is now under construction and another new *Polaris* sub tender is provided in the 1963 shipbuilding program. Including the Proteus, the Navy hopes to eventually have a force of five or six of these valuable ships to support the proposed 41-boat *Polaris* submarine program.

Technical Countdown

ELECTRONICS

Ladar (or Lopplar) Developed

A laser Doppler radar, capable of measuring velocities varying from orbital injection speeds down to almost zero, has been demonstrated successfully by Sperry Gyroscope Co. Believed to be the first of its kind, the laboratory feasibility model employs a CW helium-neon gas laser, a beam-splitting optical system, and a photomultiplier tube for detection. Developers claim a 10,000-fold increase in resolution over standard radar techniques. Such a system, they say, could be employed to advantage for guidance during space rendezvous operations.

AF Buys Big Analog System

Preflight mission studies and pilot training for the *X-20 (Dyna-Soar)* program will be performed with a new large-scale analog computer system. To be used at Edwards AFB, the system actually consists of three PACE 231-R's, built by Electronic Associates under a $679,000 contract. Each computer can be programed independently, but the combined installation provides 558 operational amplifiers.

Radar UFO's Explained?

"Angels," or false targets, that appear from time to time on radar scopes (and have at times given credence to flying saucer reports) may have been explained by P. J. Harney, a scientist at the Cambridge Research Labs. Harney says the occurrence of Benard cell circulations, which create the cloud patterns so often above Florida, results in concave, dish-like reflecting surfaces in the atmosphere at altitudes up to 6000 ft. Radar beams reflect from these surfaces to ground before being picked up by the radar antenna, resulting in a false target. A number of these reflective surfaces in an undulating layer could present a slowly changing aspect to an operator. Reflected from surface to surface, a beam could present a false moving target.

NASA to Build Computer Complex

Slidell, La., may someday house one of the nation's largest computer complexes, say officials at NASA's Michoud Operations in New Orleans. Needed to service the *Saturn* production facility at Michoud, Slidell will have roughly 150 NASA personnel by July of next year. A contract to operate the facility will be awarded next month. After the facility is in operation it will be linked directly to Michoud by landline or microwave.

Diode Converts to IR Directly

A gallium arsenide diode capable of converting an electrical signal directly into a strong infrared beam has been developed by the Lincoln Laboratory, MIT. The IR output, developers say, could carry a vast number of communication channels simultaneously over line-of-sight distances. The beam, only 100 Angstroms wide and centered at a wavelength of about 8600 A, provides a 100-mc bandwidth. This is sufficient for 20,000 voice-quality phone circuits. With an active area the size of a pinhead, the diode produces a peak power of 3 watts and conversion efficiency approaches 100%, says Lincoln Lab. Developers believe that such a beam could effectively transmit through the ionized sheath surrounding a re-entry vehicle.

Arecibo Transmitter Ready

The 2.5 Mw transmitter for the world's largest radio telescope, the 1000-ft. dish antenna being installed at Arecibo, Puerto Rico, is now completed and ready for shipment. The transmitter, which will fit into a housing 41 ft. wide x 60 ft. long x 25 ft. high, was built by Radiation, Inc., for Cornell University. Under construction for two years, the big transmitter is expected to enable detection of electrons in the ionosphere, determination of electron density by measuring total reflected power on normal and orthoganal polarizations, and an indication of electron temperature, by observing spectrum broadening in the returned pulse. The Arecibo installation is scheduled to be operational later this year.

SPACE MEDICINE

Super Centrifuge Used By GM

To study re-entry acceleration forces, General Motors engineers are experimenting with small primates in the company's high-g simulator. Called the Space Flight Acceleration Profile Simulator, the machine can accelerate to 500 g's in 12 sec. GM designers soon expect to modify the system to obtain such forces in only two seconds. Such tests will be needed, officials say, to permit development of escape modules capable of direct atmospheric re-entry. The project is company-funded.

Sophisticated Plumbing Developed

The Mechanics Research Div. of American Machine & Foundry Co. has delivered to the Aerospace Medical Lab at Wright-Patterson AFB two of three life-support system models for possible use aboard spacecraft with extended missions. The first two units—one a system capable of reclaiming potable water from a mixture of wash water and human urine, the other an improved system for converting carbon dioxide to oxygen by hydrogen reduction—were shipped last month. The third system, an incinerator device using pure oxygen to handle the waste disposal for a three-man crew on a 14-day mission, will be delivered later this year.

ADVANCED MATERIALS

High-Speed Chamber Pump-down Attained

Recent high-speed pump-down tests in Fairchild Camera and Instrument Corp.'s new 3000-cu.-ft. vacuum chamber (M/R, July 2, p. 32) have reportedly produced pressures of 4×10^{-9} torr, equivalent to roughly 380 miles altitude, within 10 hrs. Other pressure-vs.-time levels recorded were: 10^{-3} in 7 min.; 10^{-5} in 10 min.; 10^{-6} in 30 min.; and 10^{-8} in 5 hrs.

ARCAS To Update Atlantic Tracking

Cubic-built system now being delivered will increase precision and add new flexibility

by Arthur H. Collins

FIRST UNITS of a new $3-million integrated acquisition and data transmission system for existing Air Force Missile Test Center and Atlantic Missile Range tracking radars are being delivered this week.

Designed and built by the Cubic Corp., San Diego, Calif., the ARCAS (Automatic Radar Chain Acquisition System) installation will update present AMR tracking radars with more precise acquisition information for continuous and uninterrupted target tracking.

The antenna pointing system is comprised of six AN/FPQ-6 radar site and computer centers located at Cape Canaveral, Patrick AFB, Grand Bahama Island, San Salvador, Puerto Rico, and Antigua, plus a Central Computer site at the Cape's IBM 7090 facility. Provisions are included for network incorporation of MARS (Mobile Atlantic Range Stations) ships (M/R, June 4, p. 34) in late 1962 or early 1963.

ARCAS system operation is initiated by any one of several methods. But at least one ARCAS site must have sufficient information to compute and supply XYZ target acquisition or "Designate" data to a data-transmission system to be made available to all remote sites. The needed information can be obtained from radar target lock-on or manual acquisition.

AMR's AZUSA tracking system can originate initial designate data for ARCAS through the range's 7090 computer, or data can be obtained by feeding calculated target location parameters directly into the 7090. The reduced data is then made available to all six remote sites by way of AMR's communications facility.

The ARCAS network includes two major transmission systems—High Density Data System (HDDS) consisting of six information channels operating uprange from the radar sites to the Central Computer site at Cape Canaveral, plus a two-channel Low Density Data System (LDDS) consisting of a one-way channel from the Central Computer to each down-range radar site and a second channel common to all six radar site computers.

• **Picking the designator**—ARCAS system operation is under direct control of AMR's Radar Analog Data Distribution and Control function at Cape Canaveral's Master Control. This unit decides which radar/computer site will be data designator and provide target acquisition data to the other sites. The site chosen is normally the one geometrically closest to the target which also provides the most accurate designate data.

The control decision also includes determining which radar/computer sites are connected to the common channel and which are connected to the Central Computer channel. The radar sites are manually switched on and off the various channels by voice command from Master Control. After any ARCAS radar/computer site acquires a target and presents target designate data on the common channel, the system becomes self-sustaining.

The designate data can be used by any radar/computer site to determine target range, azimuth and elevation for pointing of the site's radar antenna. When the target is acquired, high-resolution radar data is used by the site's computer to generate updated information that, in turn, is placed on the common channel for use by any other site.

Because the Cape's 7090 computer is tied into the ARCAS net, it may be used to generate target acquisition data from radar/computer site information. This generated data is then made available to all ARCAS sites via the Central Computer channel.

After an extensive evaluation of many coordinate systems to determine which would provide the best use of ARCAS in line with the 13-bit-plus sign format specified by AFMTC, Cubic Corp. selected a moving, Earth-centered XYZ coordinate system in which the point of origin moves as the target moves.

• **Moving down-range** — For this dynamic system, radar/computer sites at Cape Canaveral, Grand Bahama Island, San Salvador, Puerto Rico and Antigua were selected as points of origin.

In operation, a target's course position in a trajectory is examined and the coordinates' point of origin is selected as the site geometrically closest to the target. As the target progresses along its trajectory, the tracking geometry begins to favor another point of origin for the coordinates.

When this occurs, the Central Computer automatically selects the site becoming best suited geometrically for a new point of coordinate origin for acquisition data output. In this manner, the point of origin for XYZ coordinates would move from the Cape to Grand Bahama Island to San Salvador and so on down AMR.

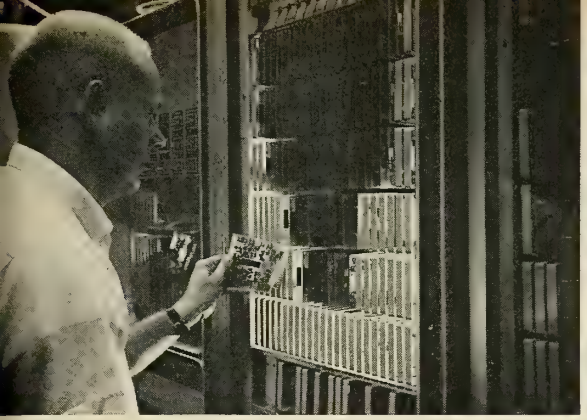
A fixed or lock-out mode is also provided in each satellite computer. Switching to this mode is manually controlled under direction of Master Control at the Cape via voice communications.

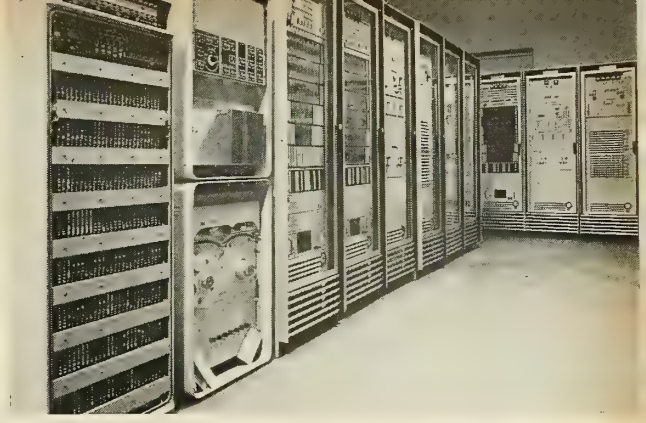
In this mode the on-site computer does not transform locally obtained radar parameters of range, azimuth and elevation into moving, Earth-centered XYZ designate data, but leaves it in local origin for that particular site. Designate data transmitted is tagged with that site's idenification. In this mode, data origin is not necessarily from the best geometrically located site.

The advantage of this is realized during special conditions such as a possible partial AMR system failure or an overall AMR system test. While in this mode, data from all sites may be examined and if any is found to be in error that site can easily be identified and isolated from the others.

• **Basic equipment alike**—The basic function of each ARCAS radar/computer site is target acquisiton and tracking, recording tracking data on magnetic tape, computation and transmission of XYZ data to other sites and the transmission of range, azimuth and elevation raw data to the Central Computer at the Cape.

All radar/computer sites have the same basic equipment: an AN/FPQ-6 tracking radar, a Digital Distribution Unit, a High Density Data Transmission System, a Low Density Data System,





LEFT: *Engineer uses plug-in test modules to run system self-test of Cubic's DH-66 Acquisition Servo System.*
RIGHT: *Overall view of one of ARCAS satellite site equipments. Left to right: 1) Compact general-purpose computer; 2) Paper tape I/O equipment; 3) DH-66 acquisition servo system; 4) DH-56 computer buffer; 5) DH-73 plotting board unit; 6) DH-69 (high-density data transmitter) plus DH-71 (low-density data transmitter) plus DH-72 (low-density data transmitter); 7) Tape handler (magnetic tape recorder/reproducer; 8) DH-10 digital distribution unit.*

Control Buffer Unit, an AN/UYK-1 general-purpose digital computer, a Magnetic Tape Unit, acquisition digital servo, Digital-to-Analog Converters and a customer-furnished plotting board.

The primary source of ARCAS raw data is the Digital Distribution Unit (DDU) which interrogates and extracts data from the AN/FPQ-6 tracking radar. DDU operation is dependent upon timing signals received from the site's Terminal Timing Unit. Since ARCAS is a real-time system, AFMTC range timing signals are used for ARCAS system synchronization, with the Terminal Timing Unit acting as an individual-site timing-control synchronizer.

The High Density Data Transmission System accepts binary digital data from the DDU and converts it into a form suitable for one-way transmission to the Central Computer. This high-density data channel is manually controlled "on and off" line at the site location under the direction of Master Control. Switching is required, since Grand Bahama and Puerto Rico share a common 3-kc facility, as do San Salvador and Antigua.

In addition to being transmitted to the Central Computer, data is recorded on magnetic tape at either 7.5 or 15 ips. For post-flight data analysis, a direct-reproduce amplifier's output is coupled to the HDDS network for transmission to the Central Computer for data evaluation. Tape units are equipped with capstan reference amplifiers to eliminate degradation of information due to variations in line voltage and frequency.

A Low Density Data Receiver accepts transmitted XYZ acquisition data from either the Central Computer or Common radar site channels—depending on manual selection directed by the Cape Canaveral Master Control.

The receiver decodes all modulating tones received to derive both the incoming data and a 480-cps clock signal required by the Control Buffer Unit.

In addition, receiver circuitry continuously samples incoming data for an end-of-word pulse. Upon its detection, a receiver-generated pulse is sent to the Control Buffer initiating data transfer into an index register.

• **The buffer**—The Control Buffer Unit has three major sections: (1) Channel A output control; (2) Channel B output control; (3) Channel A input control.

The receiver output is accepted through the Channel A input control and shifted into the register at a 480 cps rate. Following receipt of the end-of-word pulse, the accumulated data word is transferred to the index register for formatting prior to transferring received XYZ acquisition data into the on-site computer. The buffer enters this acquisition data into the computer upon receipt of a 10-pps timing pulse from the Digital Distribution Unit.

Before receipt of the timing pulse from the timing unit, the on-site computer produces target XYZ acquisition data for transmission to the other ARCAS radar/computer sites. This data is formatted in the Channel A output control prior to transmission by the Low Density Data transmitter.

The end-of-word pulse, initiated by the control buffer unit and sent to the Low Density Data transmitter at the 10pps mark, is the first data mark transmitted. After that, data is shifted out of the control buffer unit to the Low Densiy Data transmitter for this purpose. Thirty msec. after the timing pulse, Channel A output is reactivated, and the on-site computer produces XYZ coordinate information for the site plotting boards. These data parameters are sent sequentially to the Digital-to-Analog display converters to convert binary representation to analog voltages for plotting board inputs.

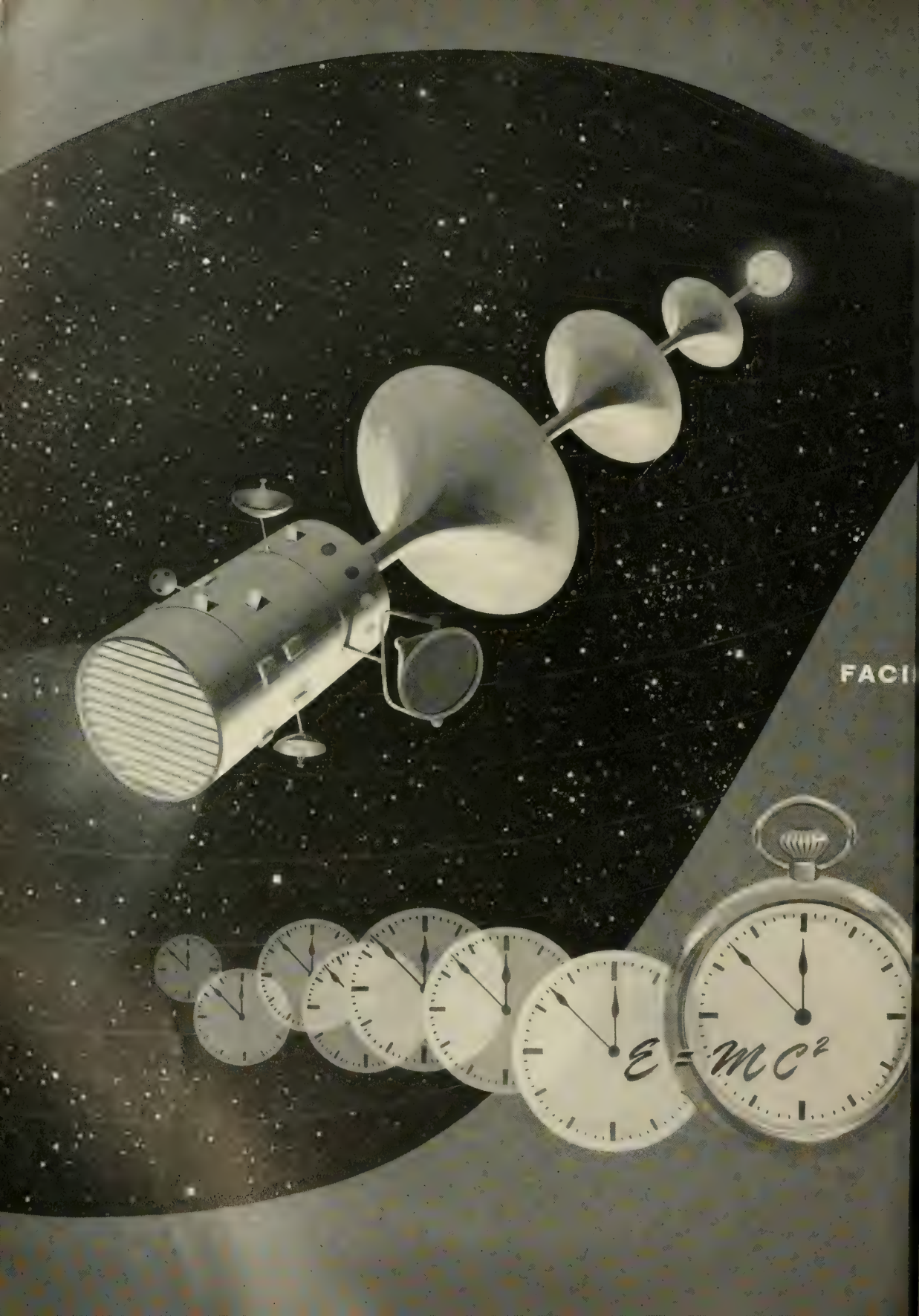
The Channel B output is assigned to acquisition data for range, azimuth, elevation and scan recommendations. An output cycle of these data parameters from the on-site computer occurs approximately 32 msec after the timing pulse.

Range acquisition data is stored in the buffer and read out to the radar at its request. Azimuth and elevation data is directly transferred to the acquisition digital servo. The control buffer also makes available to the radar, via relay closure, three scan recommendations bits as system backup.

• **Computers**—The radar site computers are Thompson Ramo Wooldridge AN/UYK-1 general-purpose digital computers with a storage capacity of 8192 words. Approximately 4265 words of storage are required for both designation and acquisition. Thus, without modification, the computer is capable of handling programs requiring over one and one half times the memory required by the ARCAS-digital system.

Each radar/computer site has the capability of performing diagnostic and self-slew tests to relieve the Central Computer site during pre-launch checks. Over-all system checks are made under the direction of the Central Computer. This is accomplished with the Central Computer placing appropriate test data on the designated channels and then comparing this data with the high-density data of radar range, azimuth and elevation received at the Central Computer site via the High Density Data System.

The ARCAS equipment is designed in independent units to minimize possibilities of a catastrophic failure of any one segment disrupting other system portions. Three separate Receiver Computer Input Units are provided for the 7090 Central Computer. Failure of one or more of these units will not affect operation of the remaining unit. ⌗


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IE FOURTH DIMENSION IN PROPULSION DEVELOPMENT

Whether the universe has a "saddle shape," or any shape at all, is a matter of interesting conjecture. The matter of space travel, however, is the subject of intense experimentation. A nuclear/thermionic/ionic propulsion system, currently being studied at Lockheed Missiles & Space Company, might well become the power source for space vehicles.

Its design incorporates a nuclear reactor only one foot in diameter, generating heat at a temperature of 1850°K. This is transmitted to banks of thermionic generators, converting the heat directly into electrical energy for the ion beam motor which uses cesium vapor as a fuel. The entire system is designed without any moving parts, minimizing the possibility of failure.

Lockheed's investigation of propulsion covers a number of potential systems. They include: plasma, ionic, nuclear, unique concepts in chemical systems involving high-energy solid and liquid propellents, combined solid-liquid chemical systems. The fundamentals of magnetohydrodynamics, as they might eventually apply to propulsion systems, are also being examined. Just as thoroughly, Lockheed probes all missile and space disciplines in depth. The extensive facilities of the research and development laboratories—together with the opportunity of working with men who are acknowledged leaders in their fields—make association with Lockheed truly rewarding and satisfying.

Lockheed Missiles and Space Company in Sunnyvale and Palo Alto, on the beautiful San Francisco Peninsula, is an exciting and challenging place to work. For further information, write Research and Development Staff, Department M-24F, 599 North Mathilda Avenue, Sunnyvale, California. An Equal Opportunity Employer.

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UK-1 Satellite Turns Up Surprises

Joint U.S.-U.K. ionospheric explorer indicates atmosphere hotter at high latitudes; a detailed report

by Charles D. LaFond

NORTHERN LATITUDE electron temperature in the outer atmosphere is considerably higher than that over the temperate zone, contrary to what terrestrial surface temperatures might lead one to expect.

Preliminary analyses of data obtained from the first joint United States-United Kingdom satellite, *S-51*, indicate that this result is only one of many surprises to come.

S-51, the first of at least three joint space ventures between the two countries, represents the first scientific frontal attack on the ionosphere to obtain data correlating variations in this region's environment with simultaneous causal effect by the Sun.

Total U.S.-U.K. expenditures in the effort are expected to approach $30 million through 1964. This investment may prove to be a bargain in light of the total effect on the world scientific community, which will receive all results of the program on a continuing basis.

• **First launch successful** — Never has so small an object owned so many names. The British dubbed it *Ariel*, but officially refer to it as *UK-1;* the National Aeronautics and Space Administration, partner in the program, designated it *S-51;* and all concerned refer to it as the *International Ionospheric Satellite*.

So far, the British have expended over a half million dollars on the first space vehicle; the U.S. funded it with $2.6 million in Fiscal 1961, $3.6 in 1962, and $0.34 million in 1963.

The U.S. expects to spend about $8 million on the second satellite, *S-52* (or *UK-2*). Over $1.5 million is already planned for *UK-3* for FY '63.

• **Higher latitudes hotter**—Project scientist Dr. A. P. Willmore of University College, London, told MISSILES AND ROCKETS recently that preliminary *UK-1* results have shown that electron temperature above 400 km altitude over the equator varies throughout the day from approximately 1000°K to 2000°K.

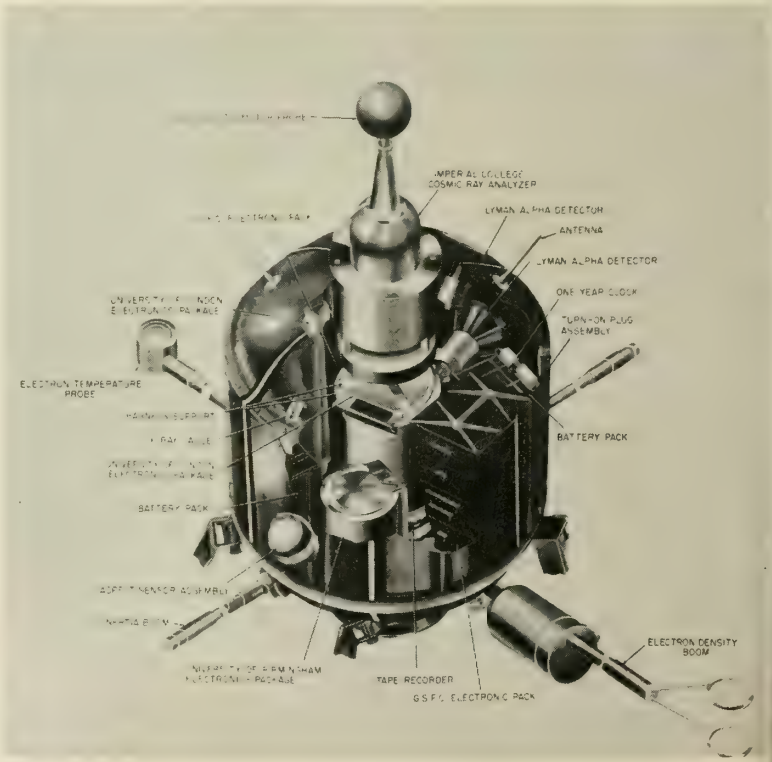
Unlike surface temperature, Willmore reported, the data indicate that the atmosphere actually increases in temperature at the higher latitudes. For example, he estimated that the temperature may reach 2300°K as a maximum in the region of Latitude 50°.

The cause of this surprising situation could, he declared, be heating of the atmosphere by solar-particle emission. The first indication supporting this belief was an analysis determining that the ion temperature is, in general, about the same as the electron temperature.

Furthermore, excluding the large variations in X-ray emission which accompany significant solar-flare activity, it was found that even the emissions from a quiet Sun vary considerably. Results so far indicate fluctuations over a short period by as much as an order or magnitude, Willmore said.

• **UK-2 progress** — The second of the U.S.-British series, *UK-2*, is now in its final design phase. Prototype tests are due to begin late this year.

Designated *S-52* by NASA, the new



UK-1, the International Ionospheric Satellite, shown in cutaway.



NASA READIES Delta vehicle prior to launch last April of first joint U.S.-U.K. satellite. First-stage Thor booster is at rear.

space package is designed to weigh less than 150 lbs. Its diameter, like *UK-1's*, will be about 23 in. The system will be built for NASA under the direction of the Air Arm Div. of Westinghouse, in Baltimore.

UK-2 will carry one experiment, Willmore said, that is entirely new for scientific satellites: a study of apparent changes in the ultraviolet light spectrum of the Sun, as it rises and sets once each orbit.

British and NASA scientists expect this approach, originated by the British Meteorological Office, to help determine the amount of light absorption in the atmosphere; from this the global distribution of ozone at heights up to 50 miles may be deduced.

Two other major experiments will be performed by *UK-2*. One is the study of radio noise intensity in the wavelength range where the ionosphere prevents radiation from reaching the Earth. Mullard Laboratory, Cambridge University, originated this task.

The other experiment, from the University of Manchester, will investigate the size distribution of micrometeorite particles encountered by the test vehicle.

Willmore indicated that, although it is still at a very immature planning stage, there will be a third U.S.-U.K. satellite. The payload has not been determined yet, but it is possible that *UK-3* will be built completely in Britain.

• **First response**—Inception of *UK-1* dates back to an invitation in mid-1959 by the U.S. National Academy of Sciences through COSPAR to its member countries to cooperate in the launch of mutually beneficial satellites. The Chairman of the British National Committe for Space Research was the first to respond.

The invitation was received enthusiastically by Committee Chairman Professor H. W. Massey, who shortly thereafter gave his approval.

In January, 1960, a team consisting of Professors Massey, Elliott, and Willmore was dispatched to Washington to present a set of proposals to NASA for the *UK-1's* scientific experiments.

These were accepted by NASA and work began almost immediately on both sides of the Atlantic. (The British, according to program officials, had anticipated an affirmative answer and started work in November, 1959.)

By the spring of 1961, prototypes for the several experimental equipments had been completed. In June the British team arrived with a first set of instruments for the *UK-1* payload.

The scientific experiments to be performed were generated by four British Universities: University College of London, the Imperial College of London, the University of Birmingham, and the University of Leicester.

In general, the British material contribution consisted of the scientific experimental equipment; the NASA contribution (through the Goddard Space Flight Center) included all other instrumentation, power supplies, maintenance of the ground stations and setting up the ground stations, development of the satellite body itself and general coordination for the project.

The principal objectives in the *UK-1* program were to acquire greater knowledge of the ionosphere and its complex relationship to the Sun, to measure the electron density and temperature and to determine the composition of positive ions, to measure the intensity of radiation from the Sun in the ultra-violet Lyman-Alpha line, and to measure cosmic rays.

UK-1 was launched on April 26 from Cape Canaveral on a three-stage *Delta* rocket. Vehicle orbital characteristics include a perigee of 242 mi., an apogee of 754 mi., and an orbital period of about 100 minutes.

• **Complex instrumentation** — Excluding instrument booms and solar-cell paddles, the satellite measures 23 in. in diameter by 23 in. in length. The 132.6-lb. spacecraft employs a plastic-bonded fiberglass outer shell—upper dome 1/16 in. thick, lower dome 1/32 in. thick. The great complexity of the scientific instrumentation in *UK-1* is indicated by the fact that there are 66 separate parameters being telemetered from these equipments. In addition, there are three sync outputs generated in the encoder.

Last May, at an Instrument Society of America meeting in Washington, D.C., two scientists closely associated with the *UK-1* program presented the first detailed description of the joint program. W. J. Mayo-Wells of the Vitro Corporation of America described the instrumentation; Willmore described the experimental approach.

Two encoders are employed. A high-speed unit, said Mayo-Wells, collects 256 channels arranged in 16 frames with each frame in turn consisting of 16 channels. Since the blank-burst interval for each channel takes 20 milliseconds, a complete high-speed telemetry sequence of 256 channels takes 5.12 sec. The low-speed encoder output, fed into a tape recorder, consists of 32 channels arranged in two frames with each frame in turn consisting of 16 channels.

Since the blank-burst interval for each channel is 0.96 sec. (e.g. 1/48th of the high-speed system) a complete low-speed telemetry sequence of 32 channels takes 30.72 sec., according to Mayo-Wells.

The frequency response of the high-speed encoder is 50 cps; that of the low-speed encoder is 50 divided by 48 cps. When the tape from the low-speed encoder is played back for transmission, it is operated at a speed 48 times that of its recording. Thus, he said, this matches the bandwidth of the high-speed encoder and its signal, enabling a single receiver on the ground to receive both modulated signals.

Communication is effected in two matrixes, and the countdown units are made up of complementary binaries. The clocks are crystal-controlled units supplied by General Time Corp. to NASA specifications. To enhance reliability in encoder design, the two encoders were separated as much as possible so that a failure in one will not cause a failure in the other, said the Vitro scientist.

The high-speed and low-speed clock systems have similar redundant design. The subcarrier oscillators are designed so that the most likely failure would be

in the "off condition," and only the information contained in the dead oscillator would be lost.

The pulse frequency modulation (PFM) telemetry system used is a particular form of time-division multiplex in which telemetered intelligence will be contained in the frequency of sequential series of 10-millisecond pulses separated by 10-millisecond intervals. Pulse frequency is derived from a set of pulse sub-carrier oscillators each having frequency range from 5 to 15 kc.

The signal is quantized into one of the one-hundred discrete 100-cps values in the 15-kc range, by recording only the number of the particular filter which contains the greatest signal.

The present state of the art of satellite PM encoders, Mayo-Wells claimed, is such that 1% accuracy on the analog information channel is the best that can be achieved. Precisions of 0.1% are possible, he said, if discriminators are used at the filter band output.

The r-f transmitter uses a modified cross-dipole or turnstile antenna array mounted on the upper part of the spacecraft. The antennas on the upper dome directly over the solar paddles are arranged in a canted or V-shape configuration. The transmitter operates at the 136-mc NASA Minitrack frequency and is used for both data transmission and as a signal source for tracking. Output power to the antenna system is 250 milliwatts, with an overall transmitter efficiency of 35%.

A 2.5-pound tape recorder, designed to store encoded data for time periods up to 100 minutes, carries 150 ft. of special lubricated tape in an endless loop configuration. Measuring 7 in. in diameter by 3 in. in height, the instrument requires a total power of 0.7 watts.

Upon command, a 2-sec. burst at 321 cps is made to provide a distinctive time-reckoning mark. This burst also is transmitted to signify successful command initiation. After the 2-sec. interval, recording ceases. The recorder plays back for 2.1 minutes and then commences recording again. Attached to the recorder is a programer which enables the command signal to require the tape recorder to be placed in play-back mode and to allow extraction of orbital data.

UK-1 is provided with a 1-year timer, according to Mayo-Wells, designed to prevent contamination of the upper atmosphere and space with unnecessary telemetry radiations. Developed from a prototype by the Naval Ordnance Laboratory as a safety device used with mines, it consists of a tensed silver wire of very small diameter around which a small lead bead has been formed. Electrolytic action occurs when a very small current of a few microamps is allowed to flow through the device.

After about a year, electrolysis will have been completed and the wire will snap, thus severing the power connections to the transmitter.

• **Power** — The power supply system consists of four solar paddles, a shunt regulator, a battery-charged current limitor, a battery switching network and two 10-cell nickel-cadmium storage batteries (one for standby). There is an under-voltage sensing circuit and a timer for shutting down the satellite transmitter for 18 hours for battery recharging.

The output as planned from the combined solar cell array is slightly in excess of 10 watts at 15 volts.

• **Novel combination** — The first detailed description of *UK-1* experiments by one of the program leaders was made by Willmore before the same ISA meeting in Washington.

The novel part of the *Ionospheric Satellite*, he stressed, is that it combines experiments to study the ionosphere and the Sun.

The ordinary, quiet ionosphere is produced largely by X-ray and ultraviolet light from the Sun, although there is some contribution from other sources such as cosmic rays. Solar disturbances may produce a tremendous modification of the ionosphere—leading to the familiar disruption of long-distance radio communication. The ionospheric changes, he declared, presumably are partly the result of changes in the electromagnetic radiation from the Sun, but are also the consequence of the emission of particles.

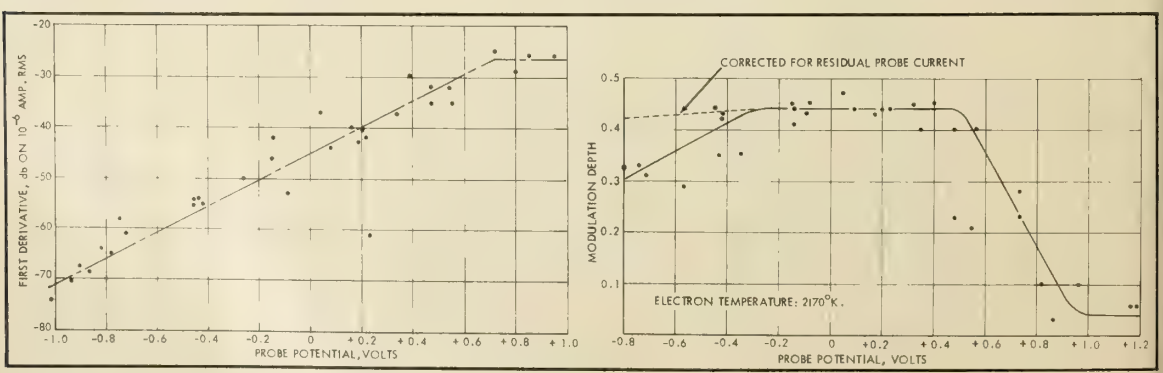
Thus, it was decided that *UK-1* would monitor the solar spectrum at two points—the Lyman-Alpha line of hydrogen at 1216° Angstroms (A), and the short X-ray region below 10 A. The Lyman-Alpha line is the longest wavelength to produce effects in the ionosphere, and X-rays from 2-10 A are the shortest wavelengths present in sufficient intensity to affect the ionosphere, he said. Since it was not practicable to observe the whole solar spectrum from the satellite, these two points were selected as most critical to monitor.

Willmore said the ionospheric experiments are designed to measure four related quantities: electron density and temperature, ion temperature and mass spectrum. Electron density is to be measured by two different methods, to provide a cross-check. First it was planned to compare the electron and ion temperatures. If in fact the atmosphere is not in thermal equilibrium (which was anticipated over most of the orbit), the difference in temperatures should provide information on the heat input to the electrons. Also, the global distribution of ion temperatures should explain more about the heat input to the atmosphere generally.

The experiment could improve our knowledge of the energy released in the atmosphere, both when the Sun is quiet and when it is active.

There are within the satellite three X-ray counters and two Lyman-Alpha ionization chambers, so arranged that the whole sky is scanned with virtually constant sensitivity once in each revolution. Two 1.2-meter booms carry ionospheric sensors.

One of these is a parallel plate condenser. This is placed in an r-f capacitance bridge, and the dielectric constant of the ionosphere determined.



TYPICAL DISTRIBUTIONS obtained from Ariel (UK-1) during 253rd orbital pass

in the "off condition," and only the information contained in the dead oscillator would be lost.

The pulse frequency modulation (PFM) telemetry system used is a particular form of time-division multiplex in which telemetered intelligence will be contained in the frequency of sequential series of 10-n by 10-millise quency is de sub-carrier o quency range

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Upon cc 321 cps is m time-reckoni transmitted mand initiat val, recording ceases. The recorder plays back for 2.1 minutes and then commences recording again. Attached to the recorder is a programer which enables the command signal to require the tape recorder to be placed in play-back mode and to allow extraction of orbital data.

UK-1 is provided with a 1-year timer, according to Mayo-Wells, designed to prevent contamination of the such as cosmic rays. Solar disturbances may produce a tremendous modification of the ionosphere—leading to the familiar disruption of long-distance radio communication. The ionospheric changes, he declared, presumably are partly the result of changes in the electromagnetic radiation from the Sun, but are also the consequence of the emission of particles.

Thus, it was decided that *UK-1* denser. This is placed in an r-f capacitance bridge, and the dielectric constant of the ionosphere determined.

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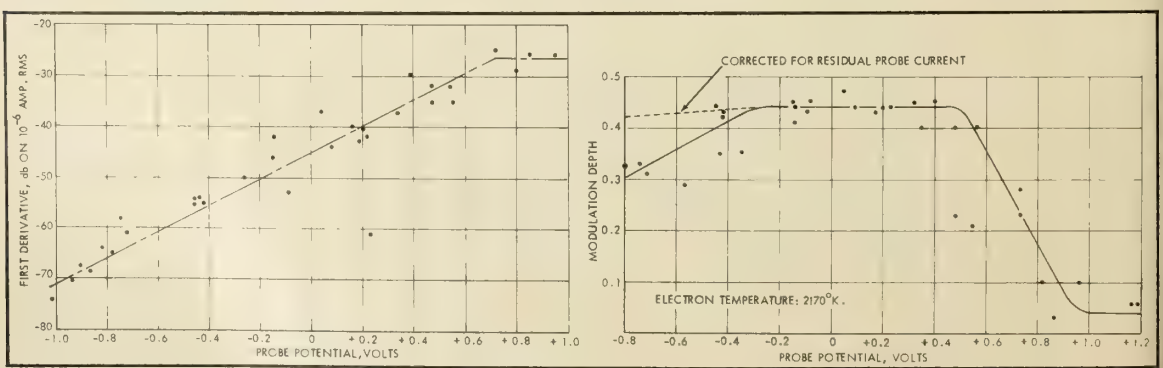
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TYPICAL DISTRIBUTIONS obtained from Ariel (UK-1) during 253rd orbital pass

From this, Willmore said, the electron density can be calculated.

On the other boom is a Langmuir probe. Another identical probe is mounted flush with the satellite skin, near the separation device. These probes measure electron density and temperature.

On the axis in front of the spacecraft in the launch configuration, the spherical ion probe is mounted on a short stalk.

• **In operation**—Dr. Willmore described the mode of operation of the ion and electron probes as follows:

By taking the voltage-current characteristic of an electrode immersed in the ionosphere, data concerning the ionospheric particles can be obtained.

In general, this involves differentiating the characteristic, which tends to amplify the errors of measurement. If i_p is the probe current, and V_p the probe potential, it can be shown that these are related to the energy distribution function f(E) of the ionospheric charged particles by

$$\frac{d^2 i_p}{dV^2_p} \quad \alpha \quad V_p^{1/2} f(E)$$

[f(E).dE] is the fraction of the particles with energies between E and E+dE.

If i_p is the current probe due to the electrons, then V_p must be negative to retard them and f(E) will then be the electron energy function. If i_p arises from positive ions, then V_p must be positive and f(E) will apply to the ions.

To determine the second derivative, d^2i_p/dV^2_p, the outputs from three voltage generators are applied simultaneously to the probe:

(1) a sinewave of small amplitude and frequency 500 cps.

(2) a second similar sinewave at 3.5 kc.

(3) a linear sweep of amplitude 8 volts.

The same circuitry is applicable to ions and electrons, except for the reversal of the sweep polarity. The other difference is in the construction of the probes. For the electrons this is simply a small 2-cm² disc, since the electron current normally swamps the ion current.

For the ions, a sphere 9 cm in diameter is used so that the current is independent of payload aspect. The sphere is surrounded by a grid which is maintained at a negative potential so that electrons are unable to reach it.

Modulation depth, said Willmore, should be constant while the probe is negative with respect to the space around it (the magnitude of the modulation depth in this case is inversely proportional to electron temperature).

The maximum value of the first

(Continued on page 45)

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Client company, well established (over 25 years), successful, highly ethical, and with a steady record of growth *through earnings*, has established this division to render systems development support and guidance to other divisions of company, in addition to systems management of prime D.O.D./N.A.S.A. contracts. Division has come within a hair's breadth of doubling its size and sales every year since its inception, now accounts for over $30 million per year in gross sales, and intends to triple this figure within the next five years. Expansion program has the full backing and support of corporate management up to and including the President.

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UTC Sees 120-in. Project As 'Moment of Truth' for Solids

In exclusive M/R interview, company's top brass also claim they're still in competition for upcoming 156-in. award

by Willard E. Wilks

SUNNYVALE, CALIF.—Reliability of the *Titan III* space booster will be stressed to the extent that the vehicle will be about twice as heavy as planned payloads should require, United Technology Corp. reported this week.

Other points brought out in a MISSILES AND ROCKETS interview with UTC top management:

—Development of the 120-in. motor should prove to be "the moment of truth"—as one executive put it—in the wrangle between liquid and solid proponents over worth of large solid boosters.

—The fact that UTC gambled on going directly into more expensive development of flightweight motors from the beginning—while others went the "safer" route with heavy boilerplate research motors—probably had a lot to do with its selection.

—UTC will do "practically none" of the 120-in. hardware work.

—Although its competitors consider UTC definitely removed from 156-in. competition, UTC does not. "We are in business to build big solids, and we'll be in 156-in. competition," says Gen. Donald L. Putt, president.

Herbert R. Lawrence, VP and director of engineering, characterized the 120-in. program as "the first real opportunity to design a system which does not have as its requirement maximum performance."

As a result, he says, "there is a very definite margin here. Performance is lower than could be obtained, so reliability of these engines should be extremely high. We have had the flexibility to trade weight for reliability wherever it was felt that additional reliability would be helpful. This is not the way to design a high-performance missile such as *Minuteman*, but it is the way to design a truck or a DC-3. This engine is specifically designed not as a weapon but as a booster for manned vehicles. It's going to work because all of the parts are designed for heavy-duty application. You could carry the weight with half as much vehicle."

Lawrence pointed out that 120-in. development will accomplish two important things in addition to giving the Air Force a 2.5-million-lb. thrust booster:

—It will provide a solid engine big enough to compete with large liquids, enabling flight test comparison. "There have been claims that solids are more reliable, simpler, less costly and can be developed more rapidly. Every one of these claims has been doubted by the liquid people. When these things start flying, we'll find out by direct comparison."

—It will enable determination of the value and uses of large solids at least up to the 156-in., since technology for development and production of both 120- and 156-in. are almost identical. "I think potential of the large engines has been underrated in industry," Lawrence says. "The weight-to-diameter ratio has been chosen as some conventional value. In the case of *Titan III* we have chosen four or five segments as the proper size. But there is no reason why we cannot go to longer lengths and therefore even higher thrust in the 156-in. We may be able to build these rockets twice as long in relation to diameter as we are planning now."

A five-segment 120-in. will produce about 1.1 million lbs. thrust. For some *Titan III* missions, the number of segments could be cut to three or even two.

• **"No controversy"**—On the solid vs. liquid issue, Gen. Putt is among those who think quick development of big solids may be the only way to beat Russia to the Moon "unless liquids get off the dime." He recently told the House Committee on Science and Astronautics that "there is no so-called controversy or conflict between liquids and solids; it is only between individuals that have not made a thorough study of the requirements and an analysis of the proper solution."

He points out *Titan III* would be sufficient for use in the lunar program utilizing the rendezvous technique, and suggests the motors could be clustered as a solid booster for a *C-1 Saturn*-type vehicle. If the 156-in. program was started immediately, he says, "motor flight tests could begin in 1964 and manned space flights in 1966." UTC could develop a 156-in. with 2-3 million lbs. thrust (depending on number of segments) that could be flight-tested in 1964, he estimated, setting a cost of $2/lb. of complete motor as a reliable figure for production.

• **Method in madness**—UTC's decision to go right into flightweight development and building of necessary production facilities from the beginning represented a more than $30-million gamble by parent company United Aircraft Corp. that it could buy a short-cut







ABOVE: **Pres. Putt:** *"We are in business to build big solids."*

LEFT TOP: **Exec. VP Adelman:** *"Flightweight from the start."*

LEFT: **VP-Engineering Lawrence:** *"We'll find out. . . ."*

to success. UAC itself has admitted to being a bit naive when it decided to challenge the established firms in solids, but according to Executive VP Barnet R. Adelman there was method to UAC's madness:

"This industry is well known for an idea thrown on the table and everybody jumps on it like wolves. When UTC was founded in mid-1958 the thought was that UAC would set up a rather sophisticated research group which would do research and come up with some significant advances, at which time we would establish an organization to exploit these advances. The idea was appealing from a policy standpoint. But the idea of doing two years of research before doing anything else appeared to be an unsound course simply because during that period industry would be advancing and developing in capability.

"We decided that what we had to do was develop a large segmented rocket and start immediately. We convinced UAC to go right into development, not just research, and that it would be necessary to provide all of the production capability right from the start. If we didn't do this, we felt, we might come up with a genuine breakthrough and not be able to exploit it.

"And we decided to go flightweight from the beginning. This was a higher-risk program since people hadn't made cases, cast solids or made nozzles in this size. The 'safe' course would have been to demonstrate we could do it in boilerplate and then start paring down. The cost is three or four times higher for flightweight. But if you are willing to pursue progress on a straight technical basis, even in case of failure you learn a great deal."

Adelman credits UAC's board with "a literally uncanny foresight" in going along with UTC recommendations. "They were willing to sit down and sign over a large sum of money. We got a charter, a time schedule and a check, with $30 million committed at the beginning."

According to Gen. Putt, a company-financed facilities expenditure of $24 million was authorized, of which $16 million has been spent. In addition, more than $17.5 million has been spent on corporate-funded research and development programs. UTC to date has acquired 5125 acres of land, including 29 acres at Sunnyvale for offices and laboratories, and 5096 near San Jose, Calif., for manufacturing and testing of large solids.

• **Board backing**—Considering the competitive situation and the fact that UTC was starting from scratch, with lots of ground to make up, its approach was sound—skip the conventional "bootstrap" philosophy, fund your own R&D, hire the brains you need. Of course this required money:

"The level of support and investment originally made in UTC exceeds any other investment for a new company in the history of space propulsion," Dr. David Altman, director of research said. "The usual approach is to grow on the basis of small government contracts, build up in bootstrap style. We didn't take this approach, which meant, probably, above all, that we had to be backed up by a unique board of directors. We had no interference, only moderate checking, from the UAC board.

"At the time we started it was not obvious that the money would be in big solids. It would have been easier for us to decide to build a small rocket for upper-stage work, and any normal board of directors would have been happier to see us do that. Any normal board would have given us a rough time, but we got a go-ahead with no questions asked."

As a result, UTC had the money to organize on a broad basis that included three major divisions at the beginning—operations, engineering and research—and to buy the talent it needed for all areas without worrying about contracts to support them. As the 120-in. came along, both Air Force and NASA picked up portions of the tab.

• **Funding freedom** — UTC's research division is set up in three major areas of activity—propellant development, materials and physical sciences. Altman's philosophy is that corporate research funds "with no questions asked" gives research people "the freedom to look at some screwy ideas and not be pinned to the wall." Most of UTC's research money has come from UAC profits, and "there is still not a government nickel in UTC facilities."

Current contracts include a $2,141,-542 Air Force award to develop advanced components for large segmented solids. The program calls for design and demonstration of advanced nozzles, hypergolic ignition and advanced thrust

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As a basic threat to electronic equipment performance and reliability, Radio Frequency Interference commands major concern today. No longer regarded as merely a nuisance, its often costly, sometimes tragic consequences underscore the need for effective control methods: A missile launching is ruined by premature triggering of electro-explosives . . . a plane's safety is threatened when interference critically disrupts communications . . . errors are caused, impairing computer calculations.



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RESEARCH DIRECTOR ALTMAN: "Any normal board would have given us a rough time, but we got a go-ahead with no questions asked."

vector control systems. The firm also is looking into nondestructive testing techniques under another $333,190 Air Force contract and has some minor research jobs with the Navy.

Altman expects to limit the amount of prime government research support to about $2 million a year. "We need an area of prime government support to have communication with Defense Department and its needs, but it is undesirable to get any one area top-heavy. We will not have enough technical talent to spare from the main corporate program."

• **Expansion** — UTC has plans to expand its research facilities for the 120-in., but not as much as will be required in other company areas. Research slated in the 120-in. development program includes further development of propellant, demonstration of propellant storage for long periods under varying temperature environment, insulation and work in areas required for optimizing the big engine over the broadest possible range of operating conditions envisioned in future applications.

Adelman, 120-in. program director, reports UTC expects to more than double its present staff of 1000, adding 1000-1500 employees over the next 18 months. Half to two-thirds of the new people will go to work in the 120-in. effort, which has comprised about 85% of the firm's work load from the outset.

"Facilities in being will handle the 120-in. program to begin with," Adelman said, "although we are going to build a new office building. We'll put the 120-in. project in a building to itself, to run essentially as a separate organization."

While UTC has facilities in being for "extensive development work," its plans for the program include addition of a new 300-gal. vertical mixer and some test stands in support of the Air Force stands at Edwards AFB.

With addition of the new mixer, Lawrence reports, "we'll be in a position to pour 3 million lbs. of propellant a month. With this capacity, we can easily handle the production effort contemplated in the present 120-in. program. The question of additional facilities beyond those existing or now planned depends upon how much more business develops for the engine. It's a very versatile engine, and there are many applications for it. Our plant is sized—current plans are such—that we could handle production of up to 10 million lbs. of propellant (20 engines) a month."

According to Gen. Putt, "there is no physical limitation here for the 120-in., or possibly the 156-in., within reasonable quantities." All of UTC's company funded facilities for big solids have been designed to handle up to 168-in.

A large percentage of the 120-in. work will be contracted out, Putt said. "We'll be doing practically none of the hardware work—cases, nozzles, TVC, will be contracted."

• **Other interests** — Although most of its effort has been in large solids, UTC, as the Space Age offspring of the most successful propulsion company in the business, also is aiming at making money in storable liquids and hybrid engines.

Following a 1959 analysis, UAC decided that with solid boosters becoming able to replace existing liquid boosters, it would be well to develop an upper-stage liquid engine. Since its Pratt & Whitney division was well along in cryogenic-turbopump liquid rocket development, UTC was given the storable-propellant, pressure-feed category to develop.

In liquids, UTC has concentrated on developing an engine with an ablative-cooled thrust chamber and having high reliability, moderately high performance and unlimited start/stop capability.

Passive Night Recon Systems Proposed

Aerojet Delft, a U.S.-Dutch firm, sees possible role for photos of Moon's dark side, drone surveillance

by Michael Getler

NEW YORK—A series of electro-optical camera and telescope systems said to be capable of passive nighttime viewing and photographic operations under extremely low light levels are being proposed for space and military reconnaissance use by the newly formed Aerojet Delft Corp., of Plainview, L.I., N.Y.

The systems basically employ a high-speed mirror optics design, combined with an electrostatically focused image intensifier tube which promises brightness gains of 1000 times.

Company engineers say one of three currently available Aerojet Delft systems—using a 350mm focal length, f/0.75 relative aperture, mirror optics system—can provide relatively high-resolution photographs at ranges from 500 ft. to several thousand ft. at shutter speeds of less than 1 sec. and under light conditions as low as 10^{-4} ft.-candles. This is roughly equivalent to light conditions on a clear but no-moon night.

The field of view is approximately 8 degrees, and angular resolution is listed as better than ½ milli-radian for high-contrast objects (contrast of log 1.0) and about 1 milli-radian for low-contrast objects (log 0.3) at the same 10^{-4} illumination levels. When fitted with a binocular telescope attachment for direct viewing, the effective brightness gain of this particular system is reported as 3000 times.

In addition to the 350mm configuration, the firm has developed two smaller systems, one a 200mm mirror device and the other a 75mm lens system. Both these systems are smaller, lighter, and offer a somewhat larger field of view than the 350mm system, but have lesser resolution capabilities under low light conditions due to the inherent decrease in the diameter of the front optics.

All three versions can be fitted with either a telescope attachment, 35mm still and movie cameras, TV camera, or rapid film processing (Polaroid) still camera. The three groups are also designed so that they require approximately the same exposure time when used with various camera attachments under similar light levels and film speeds.

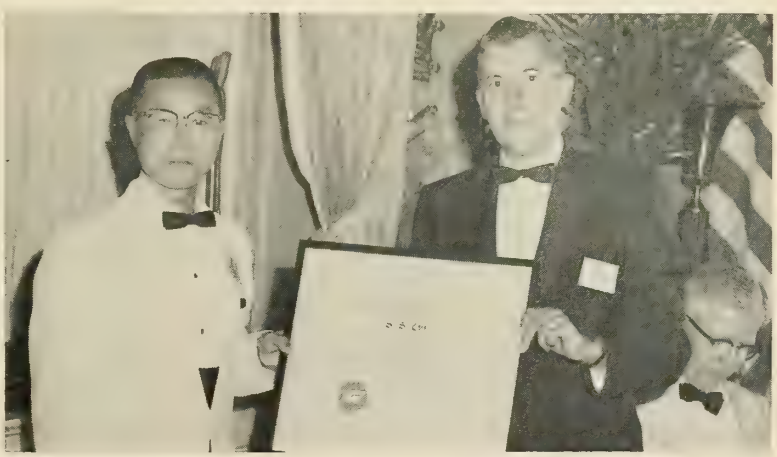
An early version of one of these Aerojet Delft systems is now reported to be under evaluation by the military for possible use in both ground and aerial reconnaissance. It is also understood that the firm will soon propose a spacecraft system based on the same electro-optical design as a means for photo-mapping the dark side of the lunar surface or any other celestial body around which a data-gathering vehicle might orbit.

Also said to be under consideration is incorporation of the image intensification tube into a ground-based space observation system now being fabricated by another firm.

In addition to these applications, the firm is also expected to propose use of these systems mated with either photographic or direct real-time readout equipment for military surveillance drones as a means of providing continuous 24-hr. reconnaissance.

• **Joint operation**—The formation of Aerojet Delft in January as a jointly held subsidiary of Aerojet-General Corp. of Azusa, Calif., and N.V. Optishe Industrie "De Oude Delft" of the Netherlands was essentially aimed at extending use of Delft-developed electro-optical techniques to U.S. space and military markets.

Delft, company officials say, is the largest producer of X-ray cameras in the world, and the high-speed optics and image intensification electronics now being packaged for nighttime viewing applications are all basically offshoots of the work done by the firm in its efforts to substantially reduce the



Martin Rewards Writers and Inventors

TO STIMULATE increased interest in technical writing and inventions, Martin Co. recently held its first annual Martin Honors Night Banquet in Washington, D.C., for some 200 employees. Cash awards of $1000 each were presented to McKay Goode and S. S. Chin, both of the Orlando Division. Goode, a design specialist in communications research, was recognized as Inventor of the Year for his role in the development of the RACEP radio-communications system. Chin, division chief of aerodynamics, was selected Author of the Year for his textbook, "Missile Configuration Design," published by McGraw-Hill Book Co. He is shown above receiving the award from Martin president William B. Bergen. Seated behind Bergen is George F. Metcalf, vice president-engineering. The winners were chosen from 510 Martin employees who received individual recognition from their divisions during 1961 for inventions and publications of technical articles, papers and books.

medical X-ray dosage.

Dan A. Kimball, Aerojet president, also heads the new organization, with former Delft vice-president J. J. Van der Sande serving as executive vice-president and general manager of the Long Island operation.

The basic 1000X image intensification tube used in the Aerojet Delft recon systems is the same as that which is now in serial production overseas for use with medical X-ray devices. The tube is a single-stage unit with a 50mm photo cathode, a 16mm phosphor anode, and the corresponding reduction ratio of 3.2:1.

Efficiency of the phosphor anode is said to be between 60 and 65 lumens per watt, with resolution slightly in excess of 100 line pairs per millimeter. Engineers report the firm is working at developing phosphors of higher efficiences and resolution qualities, but that recently achieved resolutions of 200 lps/mm were achieved only at the expense of reduced efficiencies. Efforts to date to expand tube technology have yielded laboratory-produced single-stage units with 5000X resultant gain.

Though the current tube included in the Delft design is electrostatically focused, the firm is also said to be experimenting with new electromagnetically focused tubes which, while somewhat heavier and more power-consuming, offer higher resolutions throughout the entire field of view.

The high-voltage equipment to operate the image intensifier and associated electronic circuitry (this includes an electronic shutter, for optional use instead of the manual device, with speeds stepped down from 1/100 sec. through 1 sec. and B) has reportedly undergone extensive environmental testing and operational checkout at low atmospheric pressures.

The mirror systems used by Aerojet Delft are basically derivatives of the Dr. Albert Bouwers concentric mirror meniscus system, named for the president of the Delft operation in Holland. According to engineers at the Plainview firm, the Bouwers design offers high resolution throughout a wide field of view and also reportedly eliminates six of seven basic optical system aberations. ⁂

Mobile Protection for Explosive Handlers

A COMPACT, two-ton mobile spherical barricade has been developed for safe remote-handling of hazardous explosives under testing as high-energy solid-propellant components.

Du Pont's Eastern Laboratory, Gibbstown, N.J., which designed and built the device, has employed what they believe is the most efficient type of barricade demanding the least in size and weight for the amount of explosive—in this case one pound—that is to be carried.

The 36-in.-dia. steel sphere, with its hydraulically operated door closed, will satisfactorily contain shock, sound and deadly fragments should the cargo detonate during transit.

The explosive is kept in a container at the center of the sphere while being transported. A non-rotating hydraulic cylinder moves the container from the center of the sphere to an accessible point outside.

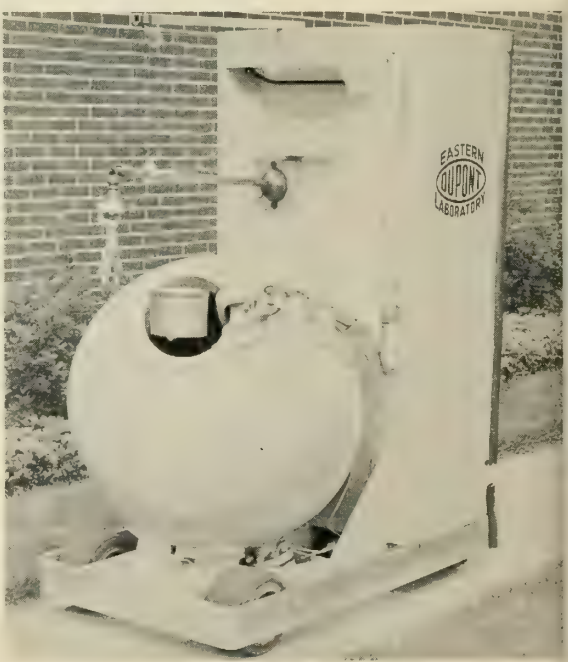
A sponge-rubber-lined steel cab in which the operator rides and controls the vehicle serves as a shield when the sphere is open.

The explosive is manipulated with an articulated tong in a ball joint mounted in the back wall of the cab. A rear-view periscope permits viewing during this operation and while the vehicle is maneuvered sphere-end first.

To ensure complete protection in the event of an explosion outside the sphere, the operator wears acoustical earmuffs, a fire-resistant aluminized suit, and an air pack.

The two-speed, battery-operated vehicle, Du Pont engineers claim, has proved to be easily maneuverable in the barricaded buildings and magazines used in the solid-propellant pilot plant at Eastern Laboratory. ⁂





LEFT: *Du Pont's mobile barricade with operator in cab.* **RIGHT:** *Close-up of the 36-in.-dia. steel sphere.*

New Industry Facilities

Wyle Laboratories has expanded its Norco (Calif.) remote test range facilities for stepped-up testing of bombs, detonators, squibs, missile destruct charges, rocket igniters, explosive bolts and other ordnance items. New equipment includes a 40-ft. drop tower, 48-ft. dia. centrifuge, and two high-capacity underground magazines for storage of large quantities of test specimens. . . . *Lear Siegler, Inc. established a new laboratory facility in Chester, Conn., to further expand its R&D activities in the ASW field. The new Special Devices Group will also develop training, simulation and oceanographic equipment for the Army, Navy and Air Force.* . . . Telecomputing Corp.'s Advanced Structures Div. moved into new headquarters in Lynwood, Calif. The new 127,000-sq.-ft. plant provides segregated facilities for development, engineering and fabrication of various thermal systems. New environmental test labs and equipment will provide for comprehensive testing. . . . *Custom Component Switches, Inc. broke ground for a new facility in Chatsworth, Calif. The company makes pressure switches for industrial and aircraft markets.* . . . Stauffer Chemical Company's Metals Div. built a large, high-vacuum, high-temperature annealing furnace which the company has made available to industry for custom work in critical defense applications, as well as for annealing and flattening of the company's refractory metal mill products and other applications. . . . *Struthers-Dunn, Inc., Pitman, N.J., will put into operation an ultra-modern, dust-free clean room and white room for military relays. The company makes relays and associated equipment for industrial and military applications.* . . . Controls Company of America will move its corporate headquarters to Melrose Park, Ill. The move will consolidate the company's R&D group and its Andrick Tool Mfg. Co. Div. with executive offices. The company manufactures controls and control system for the aerospace and other industries. . . . *The Matheson Co., Inc. is building a plant in La-Porte, Tex., to stock and ship the company's compressed gases and house an analytical laboratory for gas mixtures.* . . .

International News Briefs

Mueller-BBN,G.m.b.H., was formed in West Germany by Bolt Beranek and Newman Inc., Cambridge, Mass., and Helmut Mueller of Munich, Germany, to "take advantage of the growing Common Market need for technical competence in acoustics, vibrations and related fields." Dr. L. L. Beranek, president of BBN, will be corporate director, and Helmut Mueller, head of the company bearing his name, will be manager. . . . *ESNA Limited has been formed in Canada as a subsidiary of Elastic Stop Nut Corp., Union, N.J. The A. J. Campbell division of the new subsidiary is responsible for sales and service of Elastic Stop nuts, Rollpins and other ESN Fastener Div. products to the Canadian aerospace and metalworking industries.* . . . Nottingham Electronic Valve Co., Ltd., is marketing a closed circuit TV camera that can be plugged directly into any British domestic TV receiver. An export model adaptable to U.S. and other TV standards is planned for the near future.

News of Mergers and Acquisitions

Zero Manufacturing Co. purchased Western Devices, Inc., Inglewood, Calif., manufacturer of electronic and military consoles, cabinets and related equipment. Western will operate as a wholly-owned subsidiary and will be moved to a recently-purchased Zero plant in Burbank, Calif. . . . *Electrada Corp. acquired controlling interest in Arnoux Corp., Los Angeles electronics firm specializing in systems, instruments and components. Terms of the deal were not announced.* . . . The Jerrold Corp. acquired Analab Instrument Corp., Cedar Grove, N.J., an electronic test instrument manufacturer. . . . *Pennsalt Chemicals Corp. acquired the Sharples Corp. and its foreign subsidiaries. Sharples, to operate as a wholly-owned subsidiary, designs and engineers manufacturing processes using the company's centrifuges and other precision equipment.* . . .

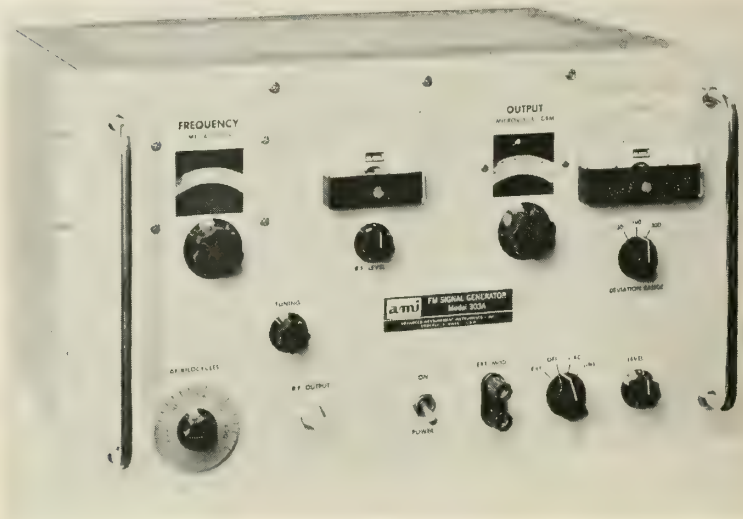
Perkin-Elmer Corp. will acquire Penn Optical Inc., Costa Mesa, Calif., pending Penn Optical stockholder approval. The company is a designer and producer of optics and optical instruments for precision alignment, calibration and measurement. It fabricates such precision instruments as spherometers, optical benches, interferometers, autocollimators and telescopes for precision measurement.

Corporate Division Changes

Eldre Components, Inc., Rochester, N.Y., established an Electronic Products Division to specialize in development and production of electronic components for the aerospace, computer and allied fields. Edward F. Snyder was named chief design engineer. . . . *MITRON Research & Development Corporation, Waltham, Mass., formed a division to provide products and engineering services in the shock and vibration field. The company specializes in research, development and applied engineering problems in fields related to the materials sciences. Within a year, the new division expects to have available special shock and vibration test equipment, plus a number of general-purpose shock and vibration isolators based on new design concepts.* . . .

New Names In The Industry

UMAC Electronics Corp. was formed in Ceiba, Puerto Rico, to manufacture printed circuits, digital modules and missile instrumentation for the aerospace industry. President is R. A. Escribano, former general manager of Instrumentation & Control Engineering, and consultant to Video Corp., San Diego.



New Product of the Week:

FM Signal Generator

AN FM SIGNAL GENERATOR developed by Advanced Measurement Instruments, Inc., permits highly accurate alignment and measurements of bandwidth, sensitivity, and distortion of FM telemetry receivers in the 215 to 450 mc. range.

Designated as the AMI Model 303A FM signal generator, the instrument has a carrier frequency continuously tunable from 215 to 450 mc., with frequency stability of ±0.5%.

The Model 303A can be modulated with telemetry sub-carrier oscillators to check modulation capabilities of telemetry receivers. Three FM modulation deviation ranges are provided: 0-30, 0-100, and 0-300 kc., with ±3% FSD on all ranges and over the entire RF range.

Circle No. 225 on Subscriber Service Card

Liquid Level Sensor

A liquid-level sensor for indicating or maintaining the proper level of stored liquids has been developed by Powerton Ultrasonics Corp.

Model UP-3001 Sonoswitch uses a semiconductor to detect the interface between air (or gas) or the liquid, and will generate a signal when this point moves as little as 1/64 in. away from the correct position.

The sensor guarantees positive switching, and is designed to be fail-safe. Operating range is from —75 to 220°F, and is independent of tank pressure or vacuum.

Circle No. 226 on Subscriber Service Card

Radiation-Resistant Cable

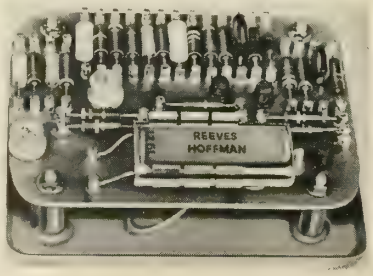
A radiation-, humidity-, and water-resistant instrumentation and control cable is available from the Instrumentation Division of Gulton Industries, Inc. Unaffected by three million roentgen per year of gamma radiation, Type RC-101 is suited for use in radiation environments of rocket research and space probes as well as in nuclear powerplant environments, both ground-based and shipborne.

Featuring adaptability to a wide range of environmental conditions, the cable offers trouble-free operation in temperatures from 0°F to 300°F, relative humidity of 100% at 70° continuous, and in applications involving continuous water immersion.

Circle No. 227 on Subscriber Service Card

Pulse Oscillator

Reeves-Hoffman Division of Dynamics Corp. is producing Model S1565, a 24-kc pulse oscillator with an accuracy of 0.01% over on operating ambient-temperature range of 10°C to 55°C. Storage temperature range is —55°C to 85°C.



It is capable of withstanding continuous vibration of up to 2 g's, over 30 to 500 cycles, or shock up to 30 g's in any direction. Its output, 6 volts across a 2000-ohm load, is a precision-positive pulse 2 to 7 microseconds.

Circle No. 228 on Subscriber Service Card

Hydraulically Tunable Magnetron

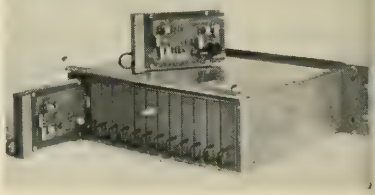
A hydraulically tunable magnetron with a tuning rate in excess of 100,000 megacycles per second has been developed by microwave engineers of the RCA Electron Tube Division. The A-1226 utilizes a coupled-cavity construction, the same type employed in the 7008 and 7111 magnetrons.

Circle No. 229 on Subscriber Service Card

Divider/Distribution System

An expendable, frequency divider and distribution system designed to perform the functions of frequency division, frequency multiplication and buffer amplification has been developed by RMS Engineering, Inc.

Designated Model FDD, the unit achieves its versatility through the use of plug-in printed-circuit modules to perform any of these functions or combination thereof. The basic chassis forms a card cage into which various modules are plugged, up to 13 modules per chassis. Only those modules necessary for individual requirements need be purchased, with ample room for expansion in the same or additional chassis as later requirements dictate.

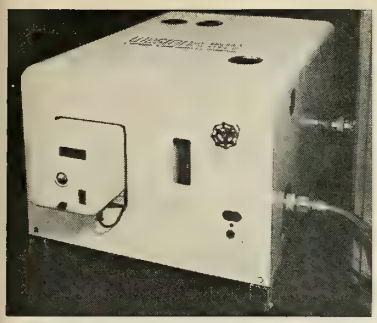


Circle No. 230 on Subscriber Service Card

Electromechanical Filter

A fluid filter which combines electrostatic separating with a mechanical filter system is available from Hydraulics, Ltd.

Designed primarily to meet the needs of hydraulic systems where maximum removal of contaminants is required, it also is ideal for cleaning other oils with similar electrical properties.



Called the Weston Electromech Filter, it uses a charged electrostatic field to remove sub-micronic as well as large particles from fluid, and provides an almost unlimited dirt-holding capacity without the usual corresponding pressure drop.

Circle No. 231 on Subscriber Service Card

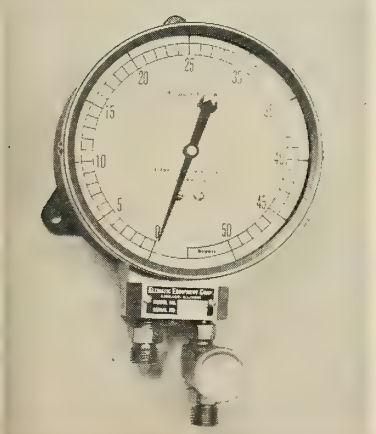
Modular Discriminator

A precision subcarrier discriminator designed primarily for missile and spacecraft ground FM telemetry stations is being marketed by Electro-Mechanical Research, Inc. Model 210 channel selectors are available for all IRIG channels and for subcarrier frequencies in the range of 300 cps. to 300 kc. Required power is less than 13 watts per discriminator.

Circle No. 232 on Subscriber Service Card

Inert Gas Flow Meter

An inert-gas flow meter is available from Elematic Equipment Corp. in flow ranges from 15LPM to 2000 CFH with input pressure from 20 psig to 150 psig. The actuating mechanism is a metering-vane device and is not affected by normal temperature changes. The unit is also unaffected by back pressures, and can be used in any position.



Circle No. 233 on Subscriber Service Card

Transportable Antenna

Andrew Corp. has available a vertical HF-log periodic antenna system that can be field-installed in eight hours, weighs less than 1500 lbs. and is transportable.

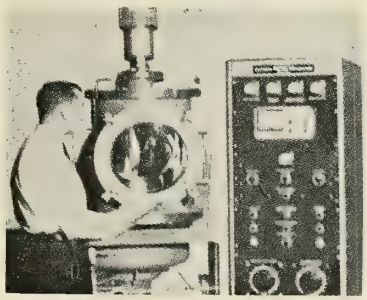
The antenna has a horizontal plane beam width of 110° and produces a cardioid pattern with a VSWR of under 2.1. Directive gain is 5 db above ¼-wave vertical monopole. The antenna has a power capability 2.5. kw.

Circle No. 234 on Subscriber Service Card

Vacuum Materials Processor

Electron Heating Corp. has developed an electron beam materials processing system.

The Model MPE100 operates at the



ultra-high vacuums necessary for impurity-free, thin-film evaporation and other material processing applications. Utilizing a unique anti-migration trap, the system blanks off in the low 10^{-8} torr range and is designed for operation in the low 10^{-7} torr range.

A simplified control system enables semi-skilled personnel to quickly and easily evaporate any material (metallic or non-metallic) at rates up to 10,000 times faster than possible by older thermal-type evaporations. Complete dimensional positioning is provided in the X, Y and Z axes, as well as automatically regulated control of emission current.

Circle No. 235 on Subscriber Service Card

Flexible Circuit Laminate

Permacel has available ET 6142, a flexible printed-circuit laminate made of TFE TEFLON film bonded to a 2-oz. electrodeposited copper foil with a specially formulated adhesive.

ET 6142 is used in making printed circuits, microwave circuits, radio and television circuits, switchgear, missile components and communications systems. Miniaturization of circuits is attained because of the high flash-over voltage, low surface resistance and low cross-talk characteristics of the base film.

Circle No. 236 on Subscriber Service Card

jpl needs

PROPULSION ENGINEERS

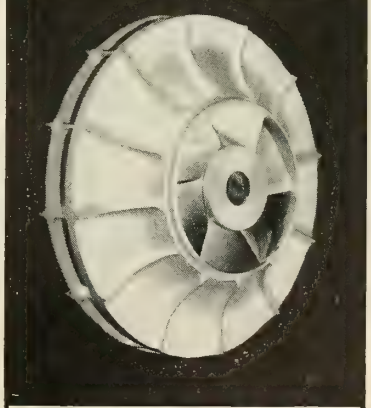
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* *M/R Research, December, 1961*

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1001 VERMONT AVENUE, N.W., WASHINGTON 5, D. C. **MISSILES AND ROCKETS**

reviews

AMERICA ON THE MOON: THE ENTERPRISE OF THE 60's, by Jay Holmes; J. B. Lippincott Co., Philadelphia and New York, 272 pp., $4.50.

Jay Holmes, a former NASA correspondent for M/R and now a consultant to several government agencies (including NASA), has written a well-documented account of the how and why of the Manned Lunar Landing Program.

The book does not confine itself to the *Apollo* program, however. It also delves into the history of U.S. rocketry and the personalities responsible for its growth. In addition, it covers in some detail the benefits in the fields of meteorology, communications and scientific research that are expected en route to the Moon.

Probably the two most fascinating chapters are those covering the events leading up to President Kennedy's May 25, 1961, speech and the subsequent reorganization of NASA to achieve the goal of landing a man on the Moon during the 1960's. Most of this material is new and reveals the built-in inertia that existed within the upper echelons of NASA to the proposed expansion of the U.S. Manned Space Program. At the time, Mr. Holmes was a consultant to James E. Webb, Space Agency administrator, and, therefore, in a unique position to observe the metamorphosis of NASA.

Although on the whole a highly interesting work, *America On The Moon* suffers from two distinct flaws. The first appears to result from a quirk of the author's personality; the second stems from the tyranny of time.

Holmes repeatedly and inexplicably injects his personal conclusions and judgments into the narrative. This is disconcerting—particularly since these editorial comments are so totally unnecessary.

The second shortcoming is more understandable. The manuscript was completed late last year, before D. Brainerd Holmes took over the Office of Manned Space Flight and before most of the critical technical and hardware decisions had been made. Therefore, the book suffers from "decisional obsolescence."

However, in the final analysis, the book is well worth reading. It is clearly and forcefully written and contains much of that contagious enthusiasm so evident in those involved in not only the Manned Lunar Landing Program but the rest of this nation's space effort as well.

J.L.T.

ADVANCES IN THE ASTRONAUTICAL SCIENCES, VOL. 7, Proceedings of the third annual West Coast meeting of the American Astronautical Society, Plenum Press, New York, 496 pp., $17.50.

Thirty-one papers given at the Seattle meeting are presented. They cover Base and Launch Operations (terrestrial operations); Satellites, Rendezvous, and Propulsion Systems (terrestrial operations); Maneuver, Astrogation, and Attitude Control (space transit operations); Extraterrestrial Operations and Human Factors (planetary operations); Re-entry, Landing, and Recovery (return operations).

NASA

CAREER APPOINTMENTS

Apollo Manned Lunar Program

SYSTEM INTEGRATION
SYSTEM CHECKOUT
RELIABILITY ASSESSMENT

Office of Manned Space Flight, Washington, D.C.

The Office of Manned Space Flight has several outstanding career positions available in the Directorate of Integration and Checkout for electronic and aeronautical engineers with B.S. or advanced degrees. Selected applicants will receive permanent appointments as Assistant Directors, Branch Chiefs, and Project Engineers to NASA Headquarters Staff in Washington, D.C.

Space Vehicle System Checkout Electronic engineers are required to direct the development of an integrated system checkout equipment for the Apollo Manned Lunar Program. Respondents should have experience in computer, data processing, analog to digital, or computer input-output equipment development. Background in the design, development, and/or project direction of system checkout equipment is desirable.

System Integration Electronic and aeronautical engineers are needed to insure the integration of the Apollo space vehicle equipment development program. The assignments require several years experience in electronic or aeronautical missile systems implementation and direction.

Reliability Assessment The engineers in this group will develop and direct the comprehensive and unique reliability assessment project for the Apollo Manned Lunar Program. Applicants must be electronic or aeronautical engineers, mathematicians or physicists and should have six to ten years' broad experience in missile system reliability program implementation.

Send brief resume in confidence to:
Director of Manned Space Flight, Dept. 134-B
National Aeronautics & Space Administration
Washington 25, D.C.

All qualified applicants will receive consideration for employment without regard to race, creed, color or national origin.

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...Less than 3 mv at 5 amps. is the average voltage drop across the snap-in contacts of CEC's 500C miniature electrical connectors. This low contact resistance makes these rectangular connectors ideal for dry circuit applications. Designed to exceed MIL-C-8384A requirements, they are available in a range of 14 to 200 contacts —with mounting hardware for flush or surface installation, right-angle or straight cable entrance and guide pin or jackscrew mating. ▪ For more data, call your nearby CEC office or write for Bulletin CEC4010-X1.

CEC

Data Recorders Division

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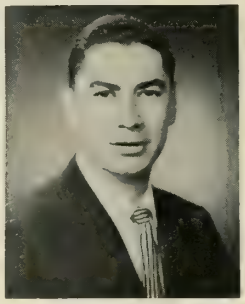
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names in the news



HILLMAN



STROGOFF



SERENO

Edward L. Dashefsky: Elected vice president of Raytheon Co., Lexington, Mass.

Ralph E. McKelvey: Named director-engineering of Timken Roller Bearing Co., Canton, Ohio.

Magnus von Braun: Named director-engineering and research, Chrysler Corp.'s Missile Div., Detroit. **O. G. White** named director-administration and comptroller.

Stanley E. G. Hillman: Appointed group executive of American Machine and Foundry Co.'s Government Products Group.

George I. Gaston: Joined Radio Corp. of America as manager of marketing for the Data Systems Center, Bethesda, Md.

Russell A. Hedden: Named vice president and general manager of the Sheffield Corp., Dayton, Ohio.

Michael A. Moscarello: Appointed operations manager for Fairchild Camera & Instrument Corp.'s newly established Defense Products Div., Palo Alto, Calif.

Alfred Strogoff: Appointed executive vice president of Adler Electronics, Inc., New Rochelle, N.Y. **Lawrence I. Marks** appointed vice president, Finance Div., and **Charles P. Johnson** appointed vice president, Government Products Div.

Robert W. Clark: Appointed manager-aviation and defense systems for General Electric Co.'s Outdoor Lighting Dept., Winston-Salem, N.C.

Harold E. Felix: Former vice president for engineering at Midwestern Instruments at Tulsa, named a principal staff engineer for the Martin Co.'s Space Systems Div., Baltimore.

Charles A. Sereno: Appointed vice president-marketing for General Precision, Inc.'s GPL Div., Pleasantville, N.Y.

Arthur J. Hatch: Appointed vice president and general manager of Data Products Corp., St. Paul, Minn.

Dr. Ronald S. Johnson: Appointed director of Plans/Economics for the Douglas Missile and Space Systems Div., Santa Monica, Calif.

Arnold F. Kossar: Promoted to director of corporate planning of the Curtiss-Wright Corp., Wood-Ridge, N.J.

Richard W. Rhyins: Named manager of advanced development engineering of Measurement Systems, Inc., South Norwalk, Conn.

Ray Roberts: Appointed manager of Space Resources, Inc., Huntsville, Ala. **Elwyn Reed** appointed manager of the Architects-Engineers' Dept.

James C. Davis, Jr. and **Frederick C. Hawkes:** Elected vice presidents of Spectran Electronics, Maynard, Mass.

Helmich W. Boessenkool: Appointed manager of international operations of Sanders Associates, Inc., Nashua, N.H.

Eli A. Kallet: Appointed manager of the space systems department of Barnes Engineering Co., Stamford, Conn. **John R. Kruse** named head of the development engineering department's electronics section. **Seymour D. Katz** appointed marketing manager of product sales for the Defense and Space Div.

Gerald J. Lynch: Elected president and chief executive officer of Menasco Manufacturing Co., Burbank, Calif.

Robert N. Lesnick: Appointed director of the Antenna Systems Laboratory at Western Development Laboratories of Philco Corp., Palo Alto, Calif.

Robert Evans: Named quality control manager of Wiggins Connectors Co., Los Angeles. **Robert Martin** promoted to field sales manager.

Air Vice-Marshall W. L. Freebody: Appointed managing director of Radio Corp. of America-Great Britain Ltd., Sunbury-on-Thames, England.

Alden C. Packard: Appointed general manager, Military Products Div., Babcock Electronics Corp., Costa Mesa, Calif.

Circle No. 11 on Subscriber Service Card

Barry R. Norman: Appointed reliability manager for Wyle Laboratories' West Coast Testing Div., El Segundo, Calif.

Pierce T. Angell: Vice president of Thompson Ramo Wooldridge, Inc., Cleveland, named assistant general manager of TAPCO Div.

Ronald C. Hinman: Appointed division manager of the Systems Management Div. of Western Gear Corp., Los Angeles.

Jack M. Mitchell: Appointed associate manager of digital computers of Scientific Data Systems, Santa Monica, Calif.

C. A. Papp: Joined Plasmadyne Corp., Santa Ana, Calif., as director of the Plasma Chemistry Laboratory.

Raymond M. Cotter: Named director of production in Atlas Chemical Industries, Inc.'s Aerospace Components Div., Wilmington, Del. **William H. Ruth** appointed director of marketing; **Donald M. Stonestrom** appointed director of product engineering; **H. Mack Truax** appointed director of quality and reliability engineering; and **Thomas A. McCahon** named division controller.

C. A. Smith: Appointed manager of technical liaison for the Electronic Defense Laboratories of Sylvania Electric Products Inc., Mountain View, Calif.

Dr. Eugene C. LaVier: Appointed director of the research division of National Co., Inc., Malden, Mass.

Charles K. Raynsford: Appointed engineering and research manager of ACF Electronics' plant in Paramus, N.J.

William H. Meckling: Named head of the Economics Div. of the Operations Evaluation Group, Washington, D. C.

Cecil A. Crafts: Appointed director of the Aeronautical Products Group at Robertshaw-Fulton's Aeronautical and Instrument Div., Anaheim, Calif. **Robert L. Carlson** to succeed him as manager of the electronic products engineering department.

Paul D. Miller: Named head of the quality control department of the United Aerospace Division of United Electro-Dynamics, Pasadena, Calif.

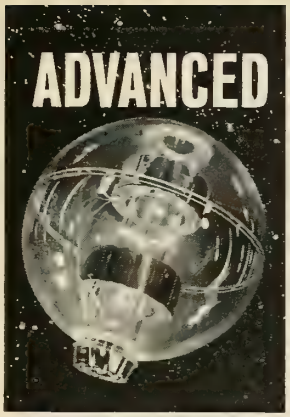
Donald N. Griffin: Appointed director of engineering of Quantic Industries Inc., Pelmec Div., San Carlos, Calif.

Herbert E. Peterson: Named new projects manager for Vitro Laboratories and will be in charge of the new Houston offices of Vitro Corp. of America.

Dr. Charles L. Bernier: Appointed director of the Armed Services Technical Information Agency, Arlington, Va.

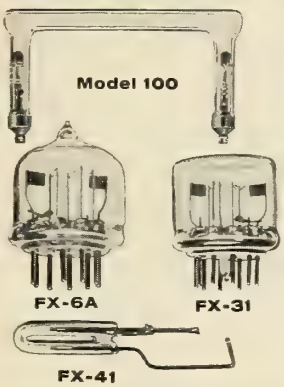
Glenn A. Walters: Appointed vice president/product research of Cubic Corp., San Diego.

ADVANCED FLASH TECHNOLOGY



for
- **Flash-induced chemical catalysis.**
- **High-speed photography of chemical and process reactions.**
- **Motion studies, shock-wave photography.**
- **Cloud chamber Physics.**
- **Deep-sea photography.**
- **U.V. printing and time-marking.**
- **Satellite beacon systems.**
- **Optical Maser (Laser) light pumps.**

EG&G's leadership in flash technology is solidly based on original contributions to the state of the art which have produced more than 40 patents for tubes, circuits and stroboscopic systems.



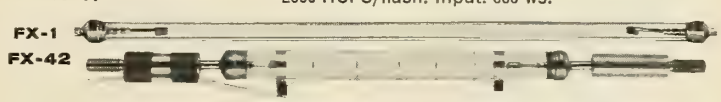
XENON FLASH TUBES

Model 100 Designed for Laser and other special applications. Tube configuration ensures maximum light intensity per unit of rod area. Output: 250 HCPS/flash. Input: 100 ws. Price: $50.

FX-31 Internally triggered. Non wandering arc. Single flash or strobe. Flat-topped for optimum optical characteristics. Output: 2.5 HCPS/flash. Input: 5 ws. Price: $30. Standard **FX-6A** type: $15.

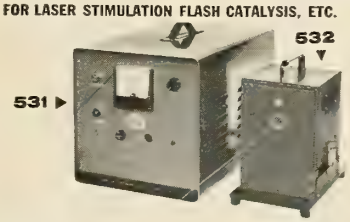
FX-41 Paper-clip size tube now under development. Inquiries invited.

FX-38 3″ arc. Output: 400 HCPS/flash. Input: 200 ws. Also available: **FX-1** Output: 2000 HCPS/flash. Input: 400 ws. Price: $50. **FX-42** Output: 2500 HCPS/flash. Input: 600 ws.



PULSED POWER SYSTEMS

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Model 531 Output: 400 ws. (1050 mfd at 900 v.) Input: 115 v. 60 cycle a.c. Price: $795.00. Model 532 Flash Head with 2 Model 100 tubes: $395.00. System will drive polished and multicoated ruby rods with low threshold. System Price: $1190.00.

Model 522 Two unit 1280 ws. system provides up to 4 kv. into 80 mfd. or 160 mfd. Triggered externally or from front panel. Drives Model 511, 512, 513 Flash Heads with 4 to 10 Model 100 tubes. Accommodates crystals 2″ long up to ½″ dia. Input: 110 v. or 220 v. 60 cycle a.c. Price: $3345.00 (complete system with 4 tubes).

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Model 530 Output: 100 ws. (260 mfd. at 900 v.) Input: 115 v. 60 cycle a.c. Price: $395.00. EG&G TR-36 external trigger transformer: $13.95. System drives most EG&G flash tubes.

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contracts

AIR FORCE

$7,700,000—**North American Aviation, Inc.'s Autonetics Div.,** Downey, Calif., for production of *Minuteman* missile guidance systems.

$2,963,229—**North American Aviation, Inc.,** Los Angeles, for work on *Minuteman* missiles.

$2,927,000—**Douglas Aircraft Co.,** Santa Monica, Calif., for research and development of the *Skybolt* missile and for production of *Skybolt* ground equipment (2 contracts).

$2,750,000—**Douglas Aircraft Co.,** Santa Monica, Calif., for work in support of missile launchers at Vandenberg AFB.

$2,297,747—**Douglas Aircraft Co.,** Santa Monica, Calif., for production of *Thor* space boosters.

$2,111,000—**International Telephone and Telegraph Co.,** for development of space communication systems at Vandenberg AFB.

$1,800,000—**Channell Cable Splicing Machine Co.,** El Monte, Calif., for splice cases for *Minuteman* intersite cable.

$1,798,801—**Boeing Co.,** Seattle, for development of *Minuteman* missiles.

$1,600,000—**North American Aviation, Inc.,** Los Angeles, for work on *Hound Dog* missiles.

$1,535,000—**Bell Aerosystems Co.,** Buffalo, N.Y., for work on a satellite propulsion system.

$1,500,000—**North American Aviation, Inc.,** for acceptance testing of *Thor* and *Jupiter* rocket engines. Work to be done at Neosho, Mo., and Canoga Park Calif.

$1,406,464—**General Electric Co.,** New York City, for design and fabrication of *Titan II* intersite communications equipment (supplemental contract).

$1,365,611—**General Dynamics Corp.,** San Diego, for work on *Atlas* space boosters (supplemental contract).

$1,140,011—**Avco Corp.,** Wilmington, Mass., for research and development for a re-entry vehicle supplemental contract).

$1,100,000—**Avco Corp.,** New York City, for testing and related work on a re-entry vehicle (supplemental contract).

$1,000,000—**Martin Marietta Corp.,** Baltimore, for design changes in *Titan I* missiles.

$91,000—**General Precision, Inc., GPL Div.,** Pleasantville, N.Y., for a program to investigate the use of lasers in airborne and spaceborne tracking devices.

$21,849—**Rocket Power, Inc.,** Mesa, Ariz., for development and flight-test of high-altitude meteorological research rockets.

ARMY

$6,002,537—**Western Electric Co.,** Burlington, N.C., for production of improved radar on the *Nike-Hercules* missile.

$3,426,480—**Northrop Corp.'s Ventura Div.,** for flight services on the RP-76 target missile to be done at Ft. Bliss, Tex., and repair and rebuilding of the target missile at El Paso, Tex.

$1,841,673—**Martin Marietta Corp.,** Baltimore, for repair parts for the *Pershing* missile.

NAVY

$53,987,001—**New York Shipbuilding Corp.,** Camden, N.J., for a nuclear-powered guided missile frigate.

$22,000,000—**General Electric Co.'s Ordnance Dept.,** Pittsfield, Mass., for production of eight advanced *Polaris* fire control systems.

$9,490,000—**General Dynamics Corp,** Pomona, Calif., for continued production of advanced *Terrier* and *Tartar* guided missiles.

$5,224,706—**North American Aviation Co.,** Los Angeles, for development of *Sparrow III* missiles and for work on navigation systems for submarines and surface ships (3 contracts).

$2,816,240—**Sperry Rand Corp.,** Great Neck, N.Y., for modification kits for missile repair sets.

$2,599,238—**Sanders Associates,** Nashua, N.H., for classified electronic equipment.

$1,452,867—**Sperry Rand Corp.,** Great Neck, N.Y., for interconnection equipment for the *Terrier* weapon system.

NASA

$22,000,000—**North American Aviation Co.,** Canoga Park, Calif., for production of the H-1 rocket engine.

$6,599,332—**Lockheed Missiles and Space Co.,** Sunnyvale, Calif., for development of a nuclear rocket test stage.

$1,300,000—**Union Carbide Corp.,** New York, for liquid-hydrogen handling facilities at Cape Canaveral.

$200,000—**Thiokol Chemical Corp., Reaction Motors Div.,** Denville, N.J., for researching oxygen difluoride as a high-energy, space-storable oxidizer for space-vehicle application.

$133,721—**Electro-Optical Systems, Inc,** Pasadena, Calif., for research in steady-state Hall-current accelerations.

$81,100—**Operations Research, Inc.,** Silver Spring, Md., for work on the *Nimbus* satellite program.

Measurement Systems, Inc., South Norwalk, Conn., for design and fabrication of an optical system for automatic tracking of a missile (undisclosed amount).

Lockheed-California Co., Burbank, Calif., for design concepts for a 10-ton-capacity cargo-passenger space transport shuttling between Earth and orbit.

DOD

$1,000,000—**Minneapolis-Honeywell Regulator Co., Heiland Div.,** Denver, for magnetic tape recording and reproducing systems for use in Project *Vela*.

INDUSTRY

$375,000—**General Electric Co.,** New York, from **Boeing Co.,** Seattle, for equipment used to adjust the directional heading of *Minuteman* ICBM's.

$260,000—**Quantic Industries, Inc.,** San Carlos, Calif., from **Thiokol Chemical Corp.,** for production of standardized safe-arm igniter mechanisms.

$150,000—**General Dynamics Corp.,** Fort Worth, Tex., from **North American Aviation, Inc.,** for research studies of nuclear fuel elements to be used in reactors for space vehicles.

Weber Aircraft Corp., Burbank, Calif., from **McDonnell Aircraft Corp.,** for design, development and testing of the ejection seat escape system for *Gemini* manned spacecraft (undisclosed amount).

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Report on UK-1

(Continued from page 31)

derivative is a function of the electron density. Thus, he declared, electron density and temperature are simply determined from the maximum value of the slope and the modulation depth. With this approach, the data are suitable for on-board processing, and only these maximum values in each sweep are stored on the tape recorder.

In the case of ions, the energy distribution function is largely determined by the satellite velocity, V_s. This is relatively large compared with the velocities of the random thermal motions. Thus, from the satellite the ions appear as a nearly homogeneous stream of velocity $-V_s$. An ion of mass m_+ will therefore have a kinetic energy of $1/2m\,V^2_s$ and the energy distribution function f(E) simply reproduces the mass distribution. However, when thermal motions are considered, each mass peak is broadened. Willmore explained that by measuring the width of the peak the ion temperature can be obtained. ⌗

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Hello, Out There

LAST WEEK, we talked by telephone to a newsman in Maine. There would be nothing particularly unusual in this but for the fact that our voices were being relayed by way of a satellite three thousand miles out in space.

This early demonstration of the quality of AT&T's *Telstar* system was impressive. No fuzz or buzz marred the clarity of the connection as our voices were flung through space to the 34-inch satellite on one frequency, amplified ten million times, and hurled back on another.

Unfortunately, we were unable to match the historic significance of this event during *Telstar's* seventh orbit with any equally historic words. Ours were more of the "Come here, Mr. Watson" variety.

This blot on our Space Age escutcheon may, however, be indicative of the practicality of the system. It was such a normal telephone conversation that it seemed to call for no historic comment.

That is *Telstar's* greatest significance. There have been space-relayed conversations and even television pictures before. It was not even the first employment of an active repeater satellite. To *Courier* belongs that honor.

But *Telstar* has proven emphatically and most successfully that such a system is feasible. It has brought to sudden dramatic realization what only a few years ago was the property of dreamers—the idea of a worldwide communications system.

The telephone conversations via *Telstar* had if anything more clarity than a cross-city call. The television pictures were of excellent quality. An unexpected bonus so early in the experiment was the TV reception by stations in England and France.

The French station at Pleumeur Bodou in Britanny reported such exceptional reception that the difference between the taped and live portions of the TV program could be distinguished. It was described by the French as being equivalent in quality to reception from a station 20 to 30 miles away.

A small portion of the program, while not of as good quality, was picked up by the Goonhilly Downs receiver in Britain and relayed to the British home television audience.

This all adds up to the realization that in a very short time satellites will have made such transatlantic TV transmission commonplace, demonstrating a peaceful utility that should satisfy the most ardent of the Space-Is-For-Peaceful-Purposes set.

It is particularly satisfying to those of us who believe strongly in the free enterprise system that private industry largely was responsible for the conception and success of *Telstar*.

The National Aeronautics and Space Administration is to be congratulated for its foresight—after some initial misgivings—in entering into the contract with AT&T. The launching from Cape Canaveral was an unqualified success. The Douglas *Thor-Delta* booster, with its Rocketdyne/Aerojet/ABL propulsion units, performed magnificently. A special word of commendation is due Bell for the guidance system which placed the satellite so precisely into orbit.

But to the American Telephone and Telegraph Co. must go the highest credit for initiation of the *Telstar* program. Without this AT&T initiative, the United States would not be enjoying its latest space triumph.

The project team under Eugene F. O'Neill has done an outstanding job by achieving, in this day of varying reliability, such performance on the first launch of a highly experimental program. The government-industry teamwork on *Telstar* is one of its most notable features.

IF WE MAY DEPART for a moment from a strictly industry viewpoint, we would like to wonder what the United States will do with this fine technical accomplishment now that it is a reality. If Frankenstein is to be considered responsible for his monster, such a question certainly is justified.

AT&T pointed out during *Telstar's* debut some of the advantages of such a worldwide television system in bringing to American homes historic events in Europe, and to the people of Europe, significant events of the U.S. scene. We can remember when the same wonderful advantages were cited for the advent of transcontinental television.

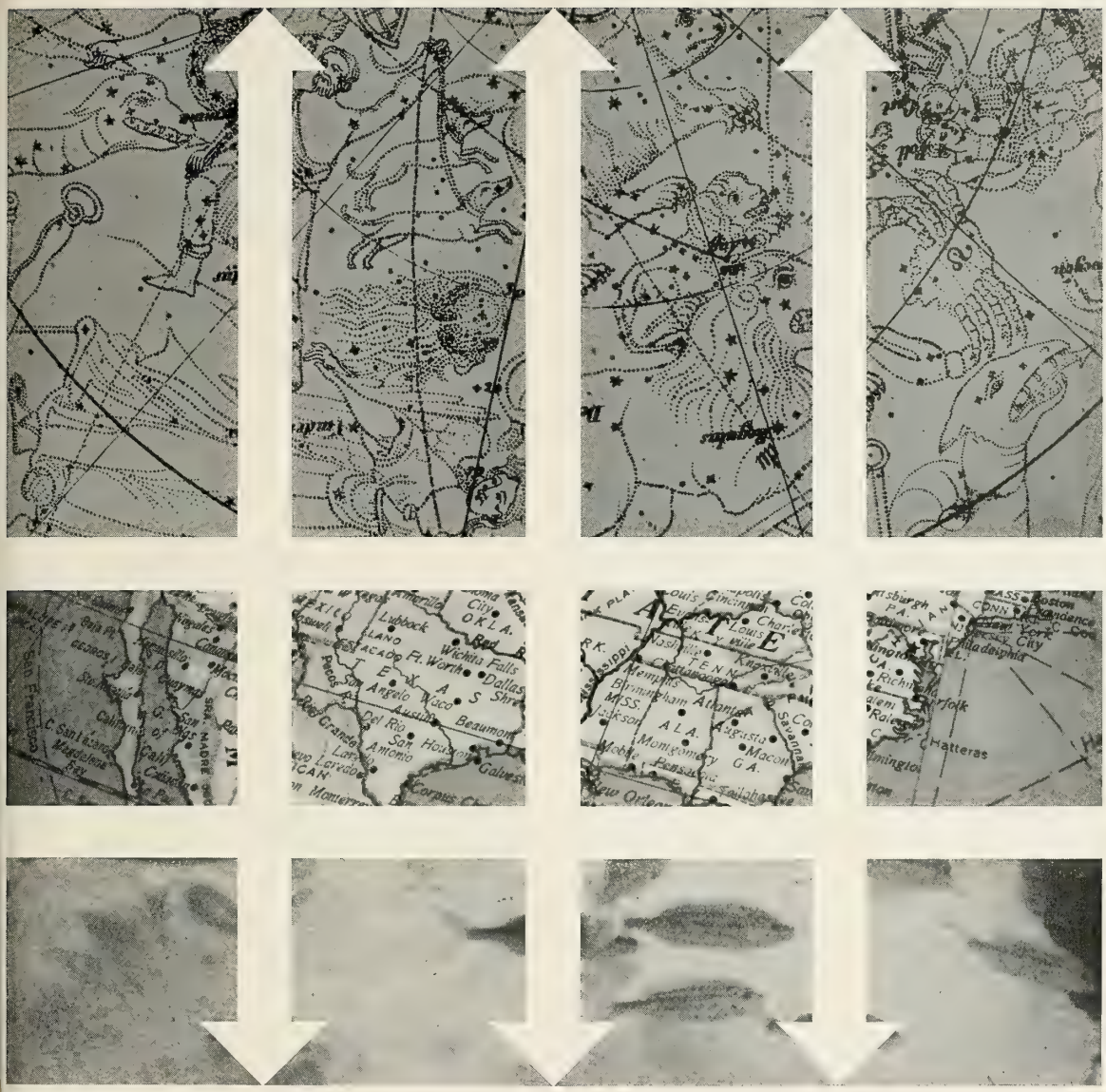
Yet how frequently is such use made of the cross-country relays? All too often, the electronic avenues are used only for the travel of the most banal products of the television wasteland.

Telstar and its progeny can be used alertly and creatively to carry to the world an image of the United States both as it is and as it should be. Or it can become an Orwellian monster, reducing the entire world to the same level of mediocrity. The thing which began in a belching cloud of smoke and flame at Cape Canaveral last week will have far-reaching effects. It is not too early to consider the eventual impact of this new technical triumph.

Nor should the industry which created it now withdraw, with no voice in how it should be used. We are citizens as well as technicians.

AT&T has played a primary role in scoring a worldwide space triumph with its technical achievement. A company of its size also is a powerful force in the land. We hope AT&T, and all others in the industry, will retain as strong an interest in the use of this new means of communication as in the technical challenge which created it.

William J. Coughlin



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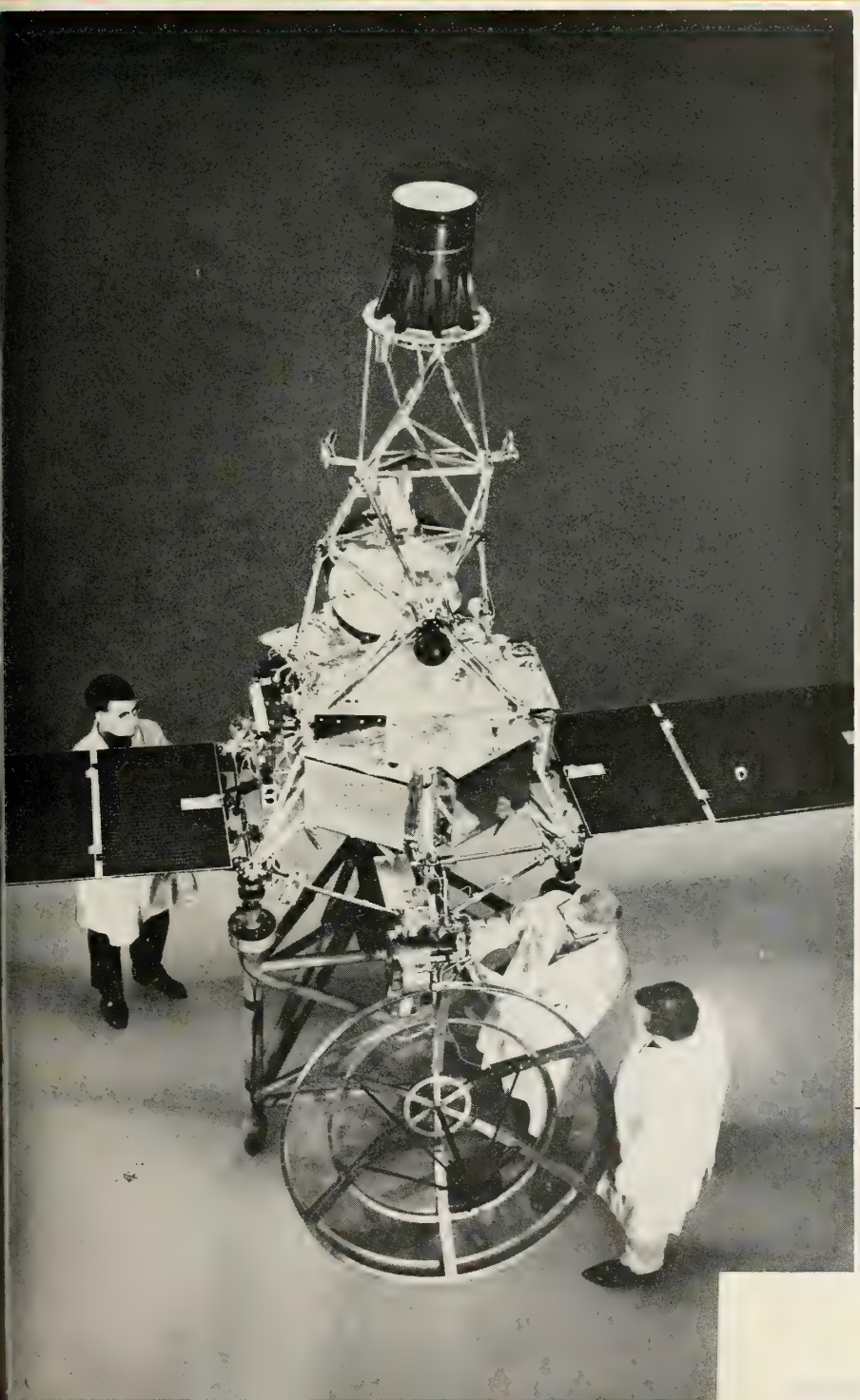
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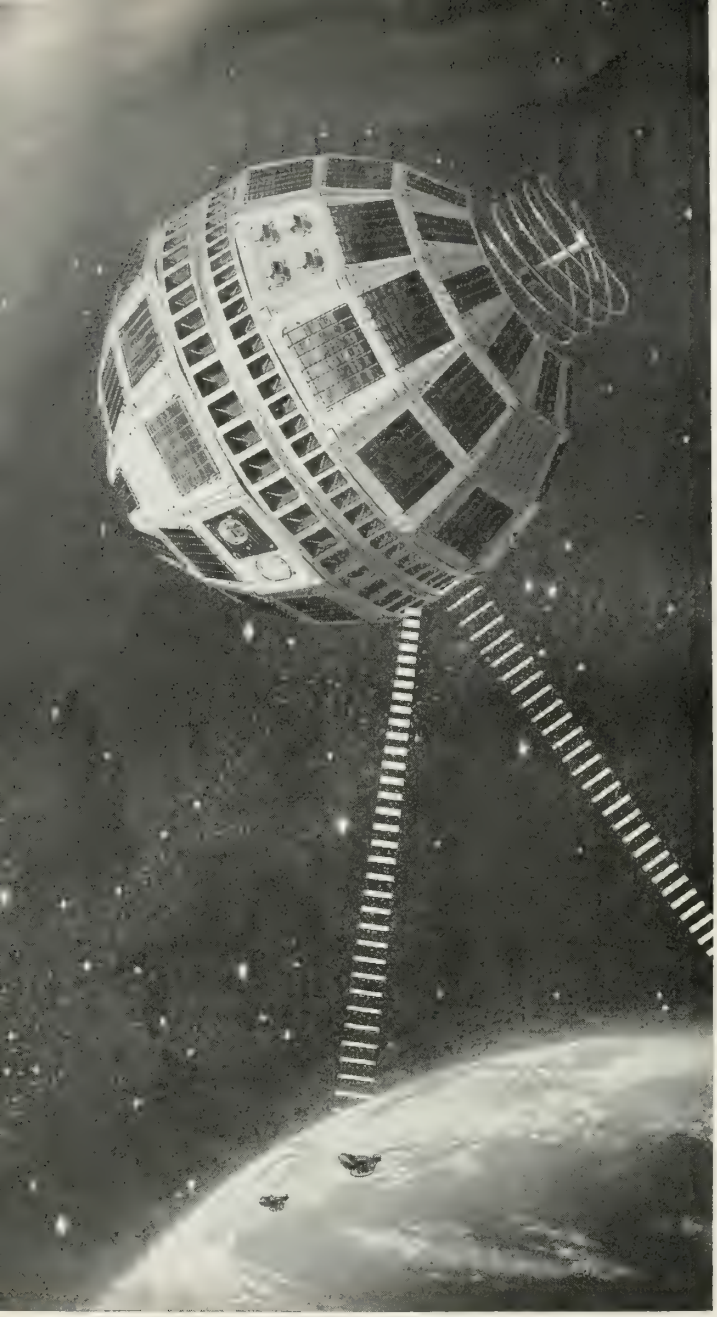


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- Complex Set For Saturn C-5
- Mariner First Big Planet Probe
- A-Firing for Davy Crockett

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INSIDE GROUND STATION "RADOME" AT ANDOVER, MAINE. Giant antenna (note man near rim of horn) concentrates signals to Telstar in a narrow, powerful beam. The same antenna also receives extremely weak signals coming from Telstar and amplifies them billions of times.



New "TELSTAR" relays phone calls and TV pictures for first time!

Bell System microwave-in-sky satell is latest communications triumph America arising from telephone resear

The world's first private enterprise commu cations satellite is now being used for drama experiments in relaying telephone calls and t vision internationally.

Its name: Telstar. It was launched from C Canaveral at Bell System expense by the Natio Aeronautics and Space Administration.

Telstar receives signals beamed to it from ground station, amplifies them and transmits th to another station on the ground below—perh an ocean away from the first one. The new satel thus acts as a microwave relay station in the s enabling voices, TV pictures and data messages leap thousands of miles in a new and exciting w

The ground stations in the U.S. now be used for Telstar were built by the Bell System Andover, Maine, and Holmdel, New Jersey. ganizations abroad have built stations in Engl and France. The latter, a near replica of the stat in Maine, was assembled with Bell System coope tion. A receiving station in Italy will be ready this year, and another in West Germany next y

Telstar is a major experimental step tow a world-wide satellite communications system was first proposed as a practical venture at Telephone Laboratories. Progress toward suc system has depended on many contributions the private communications industry, including basic components—the transistor, the solar batt the traveling wave tube, ruby masers, the w guide, and new antennas for the ground stati with innovations in circuitry—direct outgrowth Bell System research and development.

Above all else, Telstar is the latest achieven in an unending Bell System quest to develop better communications for both civilian and m tary applications.

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— of unusual interest to engineers and scientists

DURING THE NEXT FEW MONTHS the U. S. Air Force Ballistic Systems Division will shift its operations from Los Angeles to Norton Air Force Base near San Bernardino.

Concurrently, there is being established the San Bernardino Operations of Aerospace Corporation, the unique public trust organization formed in June 1960 to serve the U. S. Government. This action will insure continued and effective technical progress in the advanced programs of the Ballistic Systems Division.

Several of the principal ballistic missile programs plus advanced programs of the future will be shaped at San Bernardino. Concentrated in this friendly community a significant number of the nation's best brains will function in close interdisciplinary teamwork. *San Bernardino will be a place of challenging assignments and deep satisfaction for people concerned with America's drive for aerospace supremacy.*

The San Bernardino Operations will work closely with the established and growing Aerospace organization at El Segundo, where approximately 3600 are now working in a broad, interdisciplinary spectrum. The El Segundo staff provides advanced systems research and planning, general systems engineering and technical direction of many established ballistic missile and space programs, and laboratory research to anticipate and encourage significant state of art developments.

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Naturally, the qualifications are high. But if you are one of the few who fits them, you will probably know it instinctively. We invite you to write in confidence to Mr. Melvin Vobach, Dept. 373, Military Aircraft Systems Division, The Boeing Company, Wichita 1, Kansas.

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THE WEEKLY OF SPACE SYSTEMS ENGINEERING

missiles and rockets

Volume 11, Number 4, July 23, 1962

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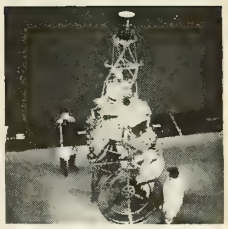
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THE COVER

Mariner I spacecraft gets final adjustments at NASA's Jet Propulsion Laboratory prior to scheduled July 21 launch. Craft's six scientific experiments will make measurements in the vicinity of Venus. See p. 32.



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We're looking for men who can't let well enough alone



Northrop-Norair needs men who ask questions; men who aren't afraid to rock the boat. In the advanced areas we're exploring at Norair, you don't dare take anything for granted. If this kind of challenge appeals to you, put down the magazine now, while it's on your mind, and write us a letter. Positions are immediately available for:

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—letters—

Secret Satellites

To the Editor:

PFC Arthur W. LeBrun (Letters, M/R, June 18, p. 7) *must* be a *philatelic cover collector!*

His comments (on "secret" satellite launchings) are correct.

I have two "contacts" there at the Pacific Missile Range (PMR), one at Point Arguello and one on Vandenberg AFB, who mail me a few covers on each launching, missile or satellite.

It might be of interest to your readers that all Air Force launchings are made from different launch complexes. All *Atlas-Agena* missiles are launched from pads at Arguello, while the *Thor-Agena* launchings are from Vandenberg, a half-mile away.

DOD releases *nothing* except the type of vehicle. The "secret satellites" components are classified, but the actual launchings *are not secret.*

With the exception of *Discoverer XVI*, all of this series of satellites have been launched with the *Thor-Agena* configuration. *Discoverer XVI* was launched with an *Atlas-Agena* rocket.

All *MIDAS* and *SAMOS* satellites have been launched with the *Atlas-Agena* rocket combinations.

It may also interest PFC LeBrun to know that the *Thor* booster has placed more satellites into orbit than any other booster.

We all make mistakes, and it's the perfection of normalcy to admit our mistakes.

Horace D. Westbrooks
Griffin, Ga.

Off-beat Thinking

To the Editor:

I would like to compliment you on the content of your excellent editorials. To my way of thinking the last page in your magazine is always the best. Thank you for an excellent insight into the work of (budget director) Mr. David E. Bell ("Curiouser and Curiouser," M/R, July 9, p. 46).

It should be very amusing to see how far this off-beat thinking will be allowed to snowball.

R. H. Oakes
Houston

Active ComSats

To the Editor:

I was interested to read the article in M/R, July 9, entitled "Telstar To Be First Active ComSat." I was a little surprised that a magazine of your repute would publish information so obviously inaccurate. I had thought it was quite well known that there have been two active communication satellites before the *Telstar* experiment. These were Projects *Score* and *Courier*, so ably carried out by the U.S. Army Signal Corps. In fact, it is interesting to note that the *Telstar* experiment is somewhat less complex in its parts density than

the *Courier* satellite, even though *Telstar* is being launched almost two years after *Courier*.

There is also another very interesting point regarding the *Telstar* project and its cost to the American public with respect to NASA's *Relay* program. If one examines these two programs, one finds that the designs and systems concepts are basically the same and it is doubtful that any significant unique information would be gathered from one over the other. Even so, the public is paying for these duplicated experiments—either through the monopoly of government taxation or the monopoly of the common carrier. I think this serves to indicate the need for a far more integrated approach to the communications satellite program within the United States. When one looks at the profusion of programs in progress or pending, for communication satellites, it is quite easy to project the combined civil, military and NASA spending to the point of over $500,000,000.00 per year. This amount is fantastic when one looks at the lack of operational capability that has resulted from the spending to date.

I hope that the slight inaccuracy mentioned will be corrected in a future issue and I certainly do not want to detract from the overall fine reporting that occurs in your magazine.

James P. McNaul
Neptune, N. J.

As we pointed out last week (M/R, July 16, p. 46), Courier was indeed the first active repeater satellite. Telstar is, however, the first realtime active repeater satellite, and its proper claim to being the first of its kind was significantly supported by the events following its launch. Courier was a delayed repeater satellite. Any claim for Score, which was an effective stunt but no part of an operating system, we do not regard as valid.—Ed.

Salary Limits

To the Editor:

Your July 9 editorial ("Curiouser and Curiouser") was most enlightening. From the picture that your editorial painted regarding the proposed ceiling of $25,000 on salaries in firms having defense contracts, it seems only fair that a similar restriction should be placed upon government executives, including the Chief Executive. After all, his "firm" does this type of work.

Frank O'Malley
San Francisco

More Than Welcome

To the Editor:

I very much appreciate being given permission to reprint figures appearing in the July 4, Aug. 15 and June 5, 1961, issues of MISSILES AND ROCKETS.

It may interest you to know that when trying to get information on space topics our first search is conducted through your magazine.

E. K. Sandeman
Guided Weapons Div.
English Electric Aviation Ltd.
Bedfordshire, England.

Four important questions you should ask before selecting any scientific or engineering computer.

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Some computers demand specialized programming personnel to operate them. Others are so simple that engineers can program their problems directly. This ease of programming saves time and increases computer use. One of the easiest computers to program and operate is Recomp. Engineers with less than eight hours instruction are able to use the computer profitably.

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MS, EE, or ME with 8 or more years experience in environmental analysis and testing of missile systems and subsystems. Duties will include the assessment, development, and analysis of criteria for environmental testing of missile systems in the areas of vibration, shock, solar simulation, and extreme temperature variance. Duties will also include the coordination and implementation of standard environmental test procedures for the total Minuteman Weapon System.

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SENIOR SYSTEMS ENGINEERS

BS or advanced degree in ME or EE with 10 years experience in transportation handling equipment, digital data processing equipment and ground power systems equipment. Duties will include technical direction on design of mechanical ground equipment and ground digital electronic equipment; and systems analysis and integration of the design and development of ground power equipment.

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BS or MS in Physics or EE with 6 to 10 years experience in the actual design and flight test of airborne missile instrumentation systems, including telemetry subsystems, CW or pulse radar tracking systems. Phase lock or digital circuitry experience is required. Duties will include detailed systems analysis in support of Systems Engineering and Technical Direction to Associate Contractors.

FLIGHT TEST ENGINEERS

BS or advanced degree in AE, EE or Physics with 3 or more years experience in systems test planning and analysis in missiles and/or A/C. Responsibilities will include processing, reduction and evaluation of flight test data including FM/FM and PCM/FM telemetry and external tracking data.

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BS or equivalent in ME or EE with 5 or more years experience in military equipment specification writing. Opportunities include the review and analysis of model specification for compliance with program requirements.

Resumes and inquiries for the above openings will receive prompt attention. Please write Dr. R. C. Potter at STL's address below. STL is an equal opportunity employer.

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The Countdown

WASHINGTON

NASA Bill Up for Final Approval

Final Congressional approval of NASA's Fiscal '63 authorization bill is expected this week. A joint conference committee is expected to split the $45-million difference between House and Senate bills. This means NASA will get almost everything it asked for in its $3.8-billion budget.

New Push Seen for Big Solids

House Science and Astronautics Committee may take another look at the large solids program if action isn't taken soon by Air Force. Members say AF, after promising to get a big solids program under way before the end of FY '62, hasn't delivered. Industry sources expect an RFP on the 260-in. by Aug. 1, however.

No MMRBM Contracts Expected Soon

Air Force officials don't anticipate any *MMRBM* contract awards until at least early September. One reason for delay: some bids had to be sent back for additional information due to contractor unfamiliarity with new Department of Defense requirements.

TOW Testing Under Way at Aberdeen

Feasibility testing of the Army's tube-launched optically-tracked wire-guided *TOW* antitank missile is under way at Aberdeen Proving Grounds. Hughes' entry reportedly hit a velocity of 8000-fps but no information is available on how this stacks up with Martin and McDonnell entries. Army declines to comment.

New Biomed Test Launches Funded

Program for a series of six launches of primate capsules by *Atlas-Agena* boosters has been approved. Air Force will provide $31 million in funding and NASA an additional $43 million. Program calls for first launch in 18 months. Orbits will range from one day to two weeks. Lockheed has been developing an ABC (Advanced Biomedical Capsule) vehicle for chimpanzees under an earlier AF study program. Environmental system is provided by Garrett Corp.

LOR Decision is Firm Unless . . .

Project *Apollo* officials are completely committed now to lunar-orbit rendezvous and expect to hold to that decision. Other methods are being studied only because some high NASA and Administration officials want to keep the program flexible in case problems develop with LOR.

Cryogenic Requirement Set for Spacecraft

One NASA requirement laid down for development of a two-man spacecraft for direct lunar flight with the *Saturn C-5:* cryogenics must be used in the propulsion system. Some *Apollo* program officials question whether this is feasible, pointing out that current state of the art does not cover propellant storage for the two-week trip required.

Camera to Replace Periscope in MA-8

A 16-mm camera is to be installed in the *MA-8 Mercury* capsule in place of the periscope. It will be used to photograph the ultraviolet spectrum. Periscope is being removed because astronauts report they can see just as well through the spacecraft's window. Shot now is scheduled for mid-September, with Sept. 18 as the current target date.

INDUSTRY

UTC Experimenting with Laser Ignition

United Technology Corp. is experimenting with laser ignition of solid rocket engines, apparently in connection with the 120-in. program. Work is classified by the Air Force. Results are said to be encouraging.

End Seen for Passive Satellites

Industry observers foresee an early end for NASA's passive communication satellite programs as a result of the *Telstar* success. Belief is that passive satellites now will add little to the fund of knowledge. Some NASA officials contend, however, that active ComSats still have not proved their feasibility.

Little Interest in Booster Shipment

A new problem has arisen for West Coast firms studying shipment of large solid boosters to Cape Canaveral or the Gulf Coast. Two of the largest West Coast-East Coast commercial steamship operators say flatly they are not interested in this type of business.

Bidding by Tape Foreseen

Several large missile/space firms are anticipating the day when complex propbsals for missile/space systems are submitted on magnetic tape—including drawings. First step, now under consideration, would be submission of computerized costing data. This would enable quick readout and evaluation by the contracting agency.

Hound Dog Production at Peak

Air Force has assigned a C-133 Douglas Cargomaster to the *Hound Dog* delivery program at North American's Space and Information Systems Division. C-133 can carry three missiles to SAC bases, compared to two carried by the C-124 previously used. This means *Hound Dog* production is reaching its maximum rate.

INTERNATIONAL

New French Range Is Planned

France is planning to build a new missile/space test center on the Atlantic Coast near Mont-de-Marsan in southwest France. Station is to be ready by 1967 when the French are expected to evacuate their test center in Algeria near Colomb Béchar.

Britons Angry over Telstar Advice

Britain's Post Office Engineering Union is blaming U.S. advice for initial poor British reception of *Telstar* transmissions. A statement claims the British equipment at Goonhilly Downs was modified after "transatlantic consultation." When the dish aerial was restored to its original condition, reception was excellent.

Career Positions

FIELD OPERATIONS ENGINEERS



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The Special Test Vehicle Project Office of the Atlantic Research Corporation has assumed significant new responsibilities and is expanding dynamically.

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The Missile/Space Week

Shots of the Week

Air Force Maj. Bob White became the first "winged astronaut" July 17, when he pushed the North American *X-15* to a record altitude of 310,000 ft. bettering by almost 12 miles the old record of 246,700 ft.

After six postponements, the flight from Edwards AFB, Calif., actually exceeded the programed altitude of 282,000 ft. because of a 284 mph differential between the planned speed and White's actual speed of 3784 mph.

"This gets better all the time," White radioed as he neared the end of his flight, "it's a fantastic view."

At the apex of his trajectory, White said that he noticed a couple of "very small, flaky objects" go by the airplane. He also reported seeing another, larger object which "looked like a piece of paper about the size of my hand." The *X-15* cameras, White believed, were not in proper position to confirm his sightings.

White's feat made him the first non-*Mercury* space pilot to win Astronaut wings for manned flight above 50 miles. He is the fifth recipient of the award.

The 38-year-old *X-15* pilot received his wings at a White House ceremony July 18. At the same time, he and the three other *X-15* pilots—Joe Walker, Cmdr. Forrest S. Peterson and Scott Crossfield—received Distinguished Service Medals and aviation's highest award, the Collier Trophy.

The day before White's record-breaking flight, *X-15* pilot Joe Walker put a sister ship through a series of seven pull-up, push-over angle-of-attack landing maneuvers to test flight pressure and drag on the craft.

Reaching an altitude of 105,000 ft. and a speed of 3700 mph, the July 16 flight appeared to be aimed at providing data on the re-entry conditions to be expected by the skip-glide *X-20* AF spacecraft.

In other shots:

• NASA successfully launched a 13-story *Echo* balloon from Cape Canaveral July 18 in a test of launching and inflation procedures for the large passive communications satellites.

Echo reached a peak altitude of about 950 miles, 12 minutes after a *Thor* booster had launched it from the Cape. After inflation the balloon re-entered the atmosphere and was destroyed. However, a movie camera and other instruments which recorded the test were safely parachuted into the Atlantic Ocean 400 miles southeast of Cape Canaveral.

• The Air Force successfully fired an *Atlas* missile from Vandenberg AFB, Calif., July 12, in a routine training launch by members of the 549th Strategic Missile Squadron from Offutt AFB, Neb.

The GD/Astronautics *Atlas-D* impacted 7000 miles from Vandenberg in the international waters of the Philippine Sea—some 200 miles from the island of Mindanao.

• Two "fully successful" Lockheed *Polaris A-2* missiles were launched July 12 from the U.S.S. John Marshall—newest of the U.S. missile-firing submarines.

The launchings from below the surface of the Atlantic Ocean off Cape Canaveral were part of the shakedown tests for the Marshall—the ninth FBM submarine. Since the tests were "secret," DOD would not release any details on the test results.

• Earlier in the day on July 12, a Boeing *Minuteman* missile blew up 50 seconds after launch from its underground silo at Cape Canaveral.

• *Nike-Zeus*—the Army's anti-missile missile and the only such active defense system under development in the U.S.—was successfully fired, July 16, at White Sands Missile Range, N.M.

All test objectives were met, the Army said.

• The Air Force launched a secret satellite," possibly a *SAMOS* or *MIDAS,* from Pt. Arguello on July 18. The usual announcement said only that the booster was an *Atlas-Agena B.*

Monkey Shots Delayed

A malfunction in an environmental control system is forcing NASA to delay three remaining shots in its high-altitude balloon tests of cosmic ray radiation.

The malfunction was blamed for the deaths of two rhesus monkeys and four hamster passengers on the first balloon flight July 14.

Space agency officials indicated that even though the animals died, there was still a good possibility that valuable data was obtained. No timetable for additional flights was set,

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but officials said they could be delayed for several weeks.

The flight was the first of four planned missions to an altitude of 128,000 ft., where the animals are subjected to approximately 50% of the primary cosmic radiation effect that exists in deep space.

NASA said the flights are the most extensive of their type to date. The flights employ balloons measuring 300 ft. in diameter and standing 384 ft. tall—the largest ever used for such work.

Launched near Goose Bay, Labrador, the balloons pick up easterly winds and fly for a distance of over 2000 mi. at an altitude of 128,000 ft. Recovery is expected in the vicinity of Edmonton, Alta. Flights should take about 55 hours.

Each balloon is designed to carry a cluster of five 36-in.-dia. capsules. One capsule contains two rhesus monkeys and four hamsters. Four capsules carry instrumentation to record the in-flight effects on the monkeys and hamsters, microbiology experiments for the Atomic Energy Commission, Oak Ridge Laboratories, University of California, and the Lawrence Radiation Laboratory, and an emulsion pack for the National Research Council of Canada to develop better techniques in the recording of long-time radiation.

Rover Moves Forward

NASA's nuclear rocket program chalked up a major advance with first successful reactor tests using liquid hydrogen as the propellant.

This is the fuel which will power the *NERVA* nuclear engine—being developed for Project *Rover*.

The recent success involves a series of "cold flow" reactor tests. In this series of experiments, the start-up operation of a Kiwi B reactor with liquid hydrogen as propellant was simulated by means of cold-flow reactor, identical to a Kiwi B reactor assembly containing no fissionable material.

The cold-flow experiments, conducted by Los Alamos Scientific Laboratory at National Rocket Development Station, Jackass Flats, Nev., are significant because they represent the first use of liquid hydrogen as a propellant in the nuclear rocket program. All previous Kiwi B reactor tests have been conducted with gaseous hydrogen.

These cold-flow operations included start-up experiments and constituted a facility check-out. The start-up experiments included:

(1) Measurement of temperatures and flow conditions in the cold flow assembly during initial "chill down" and flow tests with liquid hydrogen.

(2) Automatic controlled operation of the liquid hydrogen turbopump and reactor control systems.

(3) Establishment of operating procedures to be used in connection with later power-producing Kiwi B reactor experiments.

The cold-flow reactor is now being removed from the test cell so that installations can be begun on the first reactor which will undergo hot reactor operations using liquid hydrogen.

Shillelagh List Completed

The Army released a complete list of subcontractors on its surface-to-surface *Shillelagh* missile, for which the prime contractor is the Aeronutronic Div. of Ford Motor Co.

The list includes: Raytheon Co. —receivers; Whittaker Gyro Div., Telecomputing Corp., and Clary Dynamics Corp.—gyroscopes; Norris-Thermador Corp.—motor cases; Picatinny Arsenal and Amoco Chemicals Corp.—propulsion; Eureka-Williams Corp., Div. of National Union Electric Corp.—batteries; and Hamilton Standard Div., United Aircraft Corp.—power supplies.

Douglas, Unions Reach Accord

A three-year contract signed last week by Douglas Aircraft Co. with the International Assn. of Machinists and the United Automobile and Aircraft Workers ran into stiff opposition from the five remaining aerospace firms negotiating with the unions.

The five—Lockheed, Aerojet-General, North American, General Dynamics and Ryan—strongly criticized the agency shop clause of the Douglas agreement. Under this, non-union members would pay the union by checkoff a sum equal to union dues—a compromise solution to the unions' request for a union shop.

Meanwhile, government negotiators redoubled their efforts to settle the disputes before the July 23 deadline set for a union walkout. (Secretary Goldberg had warned that the Administration would not tolerate a strike in the industry but had not spelled out what action would be taken in event of a walkout.)

Administration officials called the Douglas pact "welcome" and "non-inflationary."

The agreement, covering 13,500 IAM workers at Santa Monica and Torrance, Calif., and 9000 UAW workers at Long Beach, Calif., Tulsa, Okla., and Charlotte, N.C., provides for 25 cents an hour over a three-year period.

In addition, Douglas agreed to begin funding a supplemental unemployment benefits program. The initial plan calls for 2 cents per hour immediately, and further negotiations on the plan must begin in no more than 30 months—about six months before the proposed contract is due to expire.

Two cents per employee hour will be earmarked for reducing the cost of health insurance to employees of dependents coverage. Unmarried children up to age 23 will be covered. One cent of the first cost-of-living payment will be funded to offset up to 50% increases in health insurance premiums.

Most Douglas employees voted on the pact Sunday; the remainder at test sites and missile bases were scheduled to vote Tuesday.



DOUGLAS and union officials clasp hands after agreement.

AF-AEC dispute continues . . .

Who'll Run SPUR-SNAP-50?

Despite Congressional prodding, mangement is still unresolved; delays threaten performance

by William Beller

DEVELOPMENT of an advanced nuclear-power system for space vehicles is becoming more deeply mired in a jurisdictional dispute between the Air Force and the Atomic Energy Commission, despite renewed congressional urgings that the agencies come to an agreement.

At issue is management of the nominal 300-kilowatt nuclear-electric system that will probably be upgraded to one megawatt or more. Known to the Air Force as *SPUR* (Space Power Unit Reactor) and to the AEC as *SNAP 50,* it will be the last big nuclear powerplant going into development for possibly the next five to 10 years.

Unless the management problem is resolved soon, the lack of overall project direction could delay development of electrical propulsion units, now expected to come of age in the early 1970's. This in turn could result in poorer performance of space vehicles as critical as military satellites, and as vital to U.S. prestige and scientific effort as planetary probes.

Furthermore, the cost in duplicated effort, if not caught in time, could run into hundreds of millions of dollars.

• **High stakes**—The agency that gets management responsibility undoubtedly will build up major facilities and thereby gain a commanding voice in all future nuclear space work. This is the reason the Air Force and the AEC—and, until recently, NASA—have been pushing so hard to get the assignment.

During the past several months, four congressional committees have raised questions about the controversy: the Joint Committee on Atomic Energy, the Senate Committee on Aeronautics and Space Sciences, the House Committee on Appropriations, and the House Committee on Science and Astronautics. In each instance, committee members were assured either that there was no problem or that it was rapidly being solved.

These hearings followed disclosure of the conflict in an exclusive MISSILES AND ROCKETS report (M/R, Feb. 19, p. 12).

The threat of renewed hearings specifically directed toward deciding who will manage the estimated $300-million development program is encouraging a faster rate of meetings among agency heads but hasn't solved the problem.



Pentagon's Gilpatric

Sees no "serious differences.

Rep. Melvin Price (D-Ill.), a member of the Joint Committee on Atomic Energy, told M/R that these conversations could go on for years without producing results. He indicated further hearings on the matter might be held by his subcommittee on research and development. At the same time, a prominent member of the House Space Committee declared that he too is increasingly disturbed by the lack of project management.

• **Where they stand**—Each agency's view of the part it should play in developing the 300-kilowatt power source is clearly dictated by self-interest: the Air Force and NASA say the user agency should manage the system's development; AEC says the manager should be the agency that by law must develop all reactors and test all nuclear units—which happens to be the AEC.

There is also a struggle to see who will be responsible for building the subsystems. The Air Force and NASA agree that AEC's engineering work is finished when it has handed over an adequate reactor. On the other hand, AEC feels its mission is to give user agencies the complete nuclear power package down to the live busbars. This means that AEC sees itself building the conversion equipment, the reactor and perhaps even the radiator.

The Air Force and AEC insist, however, that NASA errs in believing that more study is needed before development of the 300-kilowatt system is started.

Each of the three agencies appears willing to keep the *status quo,* perhaps in fear of a showdown. The argument is that for the next two or three years the work to be done will be so preliminary that duplication of effort is not a worry, and overall management is not needed.

• **DOD sees no problem**—The differences in opinion, confusion and attempts to downgrade the issues are documented in recent congressional hearings:

"Obviously the AEC is responsible for the development of the (*SNAP-50*) nuclear reactor, while NASA is responsible for the development of the energy-conversion equipment and for the mating of the reactor and the conversion equipment into a reliable and operational system." (Testimony of Harold Finger, Director of Nuclear Systems, NASA's Office of Advanced Research and Technology—in hearings before a subcommittee of the House Space Committee, March 7, 1962.)

"The only point of disagreement (with NASA) is who has the responsibility for developing the rotating equipment that can convert the power of the (*SNAP-50*) reactor into electrical current." (Testimony of Dr. Frank K. Pittman, AEC Director of Reactor Development, in hearings before a subcommittee of the House Appropriations Committee, May 29, 1962.)

"Our lack of understanding with NASA at the moment is on timing with respect to the undertaking of development of the other (than reactor) components of the (*SNAP-50*) system and the organization under which this would be done." (Testimony of Gen. A. R. Luedecke, AEC General Manager, at the same House hearings.)

Testifying about reports that there are jurisdictional disputes between the AEC, NASA and DOD over advanced nuclear-power systems for space vehicles, Roswell L. Gilpatric, deputy secretary of defense, informed the Senate Space Committee on June 13, 1962:

"I believe whatever differences may have existed at certain stages and at certain levels in the agencies have been resolved. Certainly none has reached me and Mr. McNamara. I doubt if they are of a serious nature."

On June 25, less than two weeks after these statements were made, a secret high-level meeting was held to discuss the problems attending *SNAP 50* and *SPUR*. Present: Harold Brown, director of defense R&D; Joseph Charyk, under secretary of Air Force; James E. Webb, NASA administrator; Robert C. Seamans, deputy NASA administrator; Robert Wilson, AEC commissioner; Nelson F. Sievering, Jr., AEC associate director in Division of Reactor Development; and their technical staffs.

The Air Force left this meeting reportedly believing that an accord had been reached with AEC: the project would be called *"SPUR-SNAP 50";* under the *SPUR* program, the Air Force would be responsible for the conversion subsystem; under *SNAP 50,* AEC would provide the reactor. Management of the combined program would be decided later.

When AEC was queried about this, Sievering said that the *SPUR-SNAP 50* designation has no validity, and that no agreement has been reached about the conversion equipment. He added that AEC is proceeding with the design of the *SNAP-50* reactor.

Timetable for *SNAP 50,* according to AEC: Fiscal 1963—procurement will begin of long leadtime items and fabrication of fuel elements; Fiscal 1965—operation of a lithium-cooled reactor experiment.

According to all three agencies, a prototype of the 300-kilowatt unit will fly in about 1970.

• **Reactor requirement only**—On Oct. 2, 1961, a Defense Department letter signed by Dr. Harold Brown set forth to AEC the requirement for a reactor for *SPUR*. AEC acknowledged receiving the letter, but there is no indication it has ever been answered. Curiously, shortly after the Air Force letter was received the AEC revealed its *SNAP-50* program—a program strikingly similar to the Air Force proposal for *SPUR*.

NASA feels that its rights to develop nuclear power systems are fully protected by the memorandum of understanding between itself and AEC. In February, however, Commissioner Wilson denied that such a memorandum existed. Other AEC spokesmen have said the document in question refers chiefly to the *Rover* program.

Neither the Air Force nor NASA intends to give AEC a requirement for a 300-kilowatt system. If the nuclear agency nevertheless forges ahead on its own to develop the complete system, it might then find itself in the position of the linguist who created a magnificent language and then had to search to find a nation that needed it.

• **Program costs**—An Air Force project scientist said that a conservative Air Force-AEC joint figure puts the direct cost for *SPUR-SNAP-50* system development at somewhat more than $300 million.

It's been estimated that AEC will spend $90 million for the reactor, and the Air Force will spend $60 million for the conversion subsystem, and $115 million for flight-test. But this total of only $265 million is said to be far too low. "We're only guessing at such things as booster costs and so forth," an Air Force scientist explained. "The figure of $300 million is a good one to use."

The Air Force's entire effort in space power amounted to $26 million in Fiscal 1962 for R&D contracts; for Fiscal 1963, it will be upped to $38 million. *SPUR* got $2.5 million of the money in Fiscal 1962; and will get $4 million in the current fiscal year.

Although the Air Force officially started *SPUR* in Fiscal 1960, a spokesman says it was funding AiResearch studies preliminary to *SPUR* during the preceding three years. This year the Air Force reports it has 45 contract efforts under way for the direct and indirect support of *SPUR*. Cost: about $5.5 million.

• **Another Rickover wanted**—Chiding the three agencies for having juvenile attitudes, Rep. Price told M/R, "We're not going to make decisions for them but we're definitely going to see that they make them for themselves."

He said the Joint Committee is encouraging something like a "Rickover approach" to the management of the large nuclear space units. "We're not worried about who's going to do the management as long as when it comes it eliminates conflict, is direct and immediate, and is competent."

Meanwhile, one congressional committee has three basic questions it wants to ask the warring agencies:

—If the cost and complexity of developing large nuclear space powerplants (300 kilowatts to 1 megawatt and beyond) are so great, why are three parallel efforts emerging with only 'informal" coordination between them?

—With respect to such powerplants, what "understandings" exist between AEC and NASA, and between AEC and DOD and what new ones are being sought? Are the understandings that are in effect being honored?

—Did the AEC receive requests from both the Air Force and NASA to look into developing high-power nuclear reactors for space? When, and what was AEC's reply. ⌗

Memorandum of Understanding Between AEC and NASA

I. Purpose

IT HAS BEEN recognized for some time that nuclear energy offers the potential of significant performance capability when applied to space missions. The Atomic Energy Commission and the National Aeronautics and Space Administration recognize further that the application of nuclear energy to space missions requires a joint effort to insure effective system development and to insure that the responsibilities of each agency are properly fulfilled. It is, therefore, the purpose of the present memorandum of understanding to define the areas of agency responsibility and the organizational arrangements to be followed on projects aimed at the development of nuclear rocket propulsion systems for space missions.

II. Responsibility and Authority

The Atomic Energy Commission is charged with conducting, assisting, and fostering research and development in the field of atomic energy, including the utilization of special nuclear material to generate usable energy. In addition, the AEC is charged with responsibility for a program to encourage widespread participation in the development and utilization of atomic energy for peaceful purposes to the maximum extent consistent with the common defense and security, and with the health and safety of the public.

The National Aeronautics and Space Administration is charged with conducting the aeronautical and space activities of the United States for peaceful purposes. These aeronautical and space activities include research into and the solution of problems of flight within and outside the Earth's atmosphere and the development, construction, testing, and operation for research purposes of aeronautical and space vehicles.

In accordance with the above statutory responsibility, it is agreed that:

1. The AEC has the primary responsibility for conducting research and development on all types of nuclear reactors and reactor components including those required for aeronautical or space missions specified by the NASA.

2. The NASA has the primary responsibility for conducting research and development on components and subsystems of nuclear systems other than the reactor, reactor components, and isotope power units.

3. The NASA has the primary responsibility for integration of the reactor into nuclear propulsion systems and nuclear electric power generation systems to arrive at operational and reliable systems. These systems shall be subject to review by AEC with respect to nuclear safety, and shall be subject to applicable licensing and regulatory provisions of the Atomic Energy Act of 1954 as amended.

III. Management Organization

In order to assure the formulation and execution of a well-integrated development program that fulfills the responsibilities of each of the agencies and that is responsive to the space system requirements of the NASA, it is agreed that a single project office combining NASA and AEC personnel should be and, hereby is, organized. This office will report to the Director of the Division of Reactor Development of the AEC and to the Director of Launch Vehicle Programs in the NASA. The project office will be responsible for all aspects of the joint NASA-AEC nuclear rocket propulsion program. The office will be staffed jointly by NASA and AEC.

Contract work in the respective areas of responsibility will be administered through the normal contracting procedures in each agency.

Signed Aug. 29, 1960:

John A. McCone, Chairman,
U. S. Atomic Energy Commission

Signed Aug. 26, 1960:

T. Keith Glennan, Administrator,
National Aeronautics and Space Administration

For Advanced Saturn . . .

Design Set for Launch Complex 39

2500-ton crawler will transport giant booster to its pad; bids for assembly building to be requested soon

NASA HAS FIRMED UP the design of the *Advanced Saturn* launch complex including the use of a 2500-ton crawler vehicle to transport the giant booster to its launch pad.

The *Advanced Saturn* will be launched from launch complex 39 in the NASA land area at Cape Canaveral, Fla.

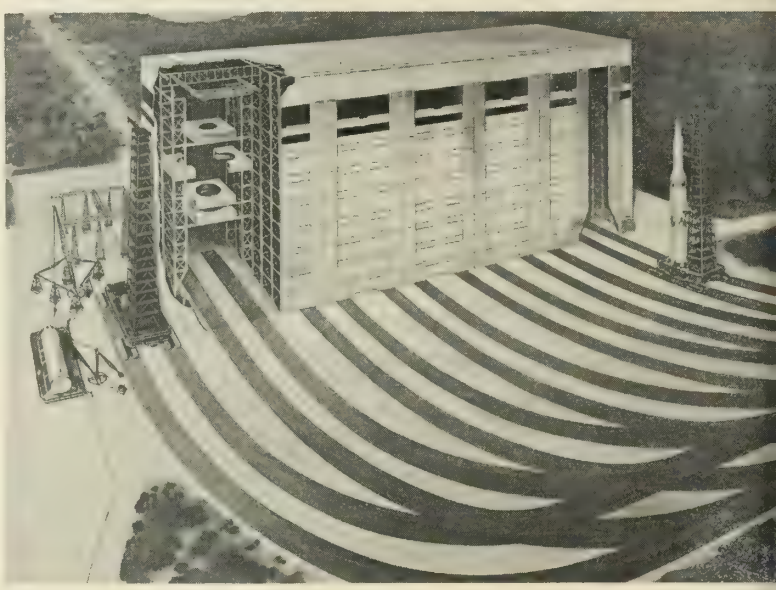
The crawler transportation method for the 350-ft.-high launch vehicle is part of the basic design plan announced by the space agency. Another major undertaking will be the construction of a large vertical assembly building in which six of the launch vehicles can be built.

NASA said that proposals for the building design will be requested within a month. No decision has been made as to how soon development of the crawler will be initiated.

First launch from the complex is expected in 1965.

NASA has previously determined that the *Advanced Saturn* would be transported vertically to its launch site after assembly—including the *Apollo* spacecraft—and checkout in a rear area.

The decision for the crawler was made by D. Brainerd Holmes, NASA director of Manned Space Flight, on the recommendation of Dr. Kurt H. Debus, director of NASA's Launch Operations Center.



ARTIST'S CONCEPT of proposed Vertical Assembly Building. At right is the crawler vehicle carrying Advanced Saturn, spacecraft and umbilical tower.

• **The complex**—Major elements of Complex 39, which will cover about 30,000 acres including safety zone, are:

—A vertical assembly building with bays to assemble and check out six *C-5's* at once. The building—48 stories high, more than two city blocks long and 230 ft. deep—will completely enclose the rockets during pre-launch activity. It will be some 150 ft. higher than Florida's tallest building—the Dade County Courthouse.

—Four launch pads about 9000 ft. apart spread along the Atlantic Ocean from False Cape north to Playalinda Beach. Each pad will include a ground-level flame deflector, a platform approached by inclined ramp to support the crawler, and a propellant and pressurized gas loading system. All other launch equipment — pedestal, launch rack and umbilical tower—will be transported to the pad by the crawler.

—Specially constructed roadways on which the crawler will cover the two miles separating the forward pads from the assembly building.

—An arming tower along the main artery of the roadway from which explosive charges necessary for flight can be attached to the *C-5* after it leaves the assembly building.

—A canal on which a barge can deliver individual *C-5* stages to the vertical assembly building from the Intracoastal Waterway.

The crawler was one of three systems considered for moving the *C-5* to the launch pad. Other possibilities involved use of a barge on a canal or rail system.

Dr. Debus said the major reason for selection of the crawler is that similar devices of about the size required already are in commerical use, chiefly in large strip-mining operations.

Here is how the system will work. In the assembly building, the three-stage *Saturn C-5* will be erected, mated to the *Apollo* spacecraft, and checked out on a launch rack that also supports its 400-ft. umbilical tower.

When checkout is complete, the crawler—some 130 ft. long and 115 ft. wide—will move to the building on eight tank-type treads. It will be driven by electric motors powered by diesel-driven generators.

The crawler will pick up the rack with the *C-5* and spacecraft and the umbilical tower, and carry it the two miles over special roadways to the launch pad, with a stop at the arming tower. The total transported load will weigh some 3000 tons—the 250-ton unfueled *C-5*, the 750-ton umbilical tower and the 2000-ton rack.

During the journey, the 33-ft.-dia.-rocket will be kept balanced by four load-leveling hydraulic cylinders. The cylinders—each 4 ft. in diameter—are 90 ft. apart.

At the pad, the 20-ft. high crawler will use the cylinder to lower the rack and vehicle onto support blocks on the launch platform. ⌗

Contracts Pending on Lunar Landing Logistics Vehicle

by Hal Taylor

TWO STUDY CONTRACTS are expected to be awarded within a month for a Lunar Landing Logistics Vehicle which has a total development pricetag of $500 million.

"One study will be concerned with the vehicle and the other its payload," according to Dr. Joseph Shea, Director of Systems Engineering in NASA's Office of Manned Space Flight.

Shea told MISSILES AND ROCKETS that during the three-to-four-month study of contracts, industry will be asked to look at two possible versions of the lunar supply vehicle.

One would utilize the *Saturn C-1B* launch vehicle and weigh 2500 lbs. The advanced version would be boosted by the *Saturn C-5* and weigh in the neighborhood of 28,000 lbs.

"One question we want to answer is whether we should build only one or both of the vehicles," Shea said.

The vehicle, he continued, will primarily be a lunar-landing stage with liquid hydrogen as the propellant. The $500-million pricetag will cover costs of the stage only. Its payload will be built by one or more firms. He gave no estimates for the latter cost.

Shea headed the systems engineering study which recently resulted in the selection of lunar-orbit rendezvous (LOR) as the primary method of achieving a manned lunar landing.

His comments came shortly after NASA announced another major step in Project *Apollo*—the selection of General Dynamics/Astronautics and The Martin Co. to perform two parallel $1-million design studies of the *Nova* super-booster.

Shea also disclosed that:

—Development of the M-1 engine will not be bothered by the delay on *Nova*. The M-1 is the pacing item in the *Nova* program. The current timetable calls for the delivery of the M-1 engine in 1965.

—The contractor selected to build the lunar excursion vehicle of the three-module LOR *Apollo* capsule will spend the first three months in a preliminary design study.

The vehicle will have one or more engines using Earth-storable hypergolic propellants. It will have a guidance system similar to the one currently being developed for *Apollo* by Massachusetts Institute of Technology.

—The Office of Manned Space Flight —with the primary LOR decision made —is now engaged in a detailed scheduling and cost study for the *Apollo* program. (While Shea and other NASA officials will say only that the U.S. manned lunar landing will be made before the end of the decade, informed sources report that a 1968 target is possible. Some optimists still are holding out for a late 1967 flight).

Shea declared that the lunar supply vehicle is a requirement in any method used to achieve a manned lunar landing. He did not say when actual hardware development would start, but it could come in the next few months.

The vehicle will replace the *Prospector* spacecraft, which was killed by Congress. That program provided only for the landing of scientific instruments on the Moon.

The new vehicle will be used to supply the manned lunar landing.

It may land on the Moon before the *Apollo* spacecraft for site survey work and also to mark the landing site with beacons.

It will also carry survival gear such as extra space suits, oxygen supplies, and an emergency shelter. Later, it will probably be used to land mobile equipment such as jeeps for lunar transportation. NASA also plans to use it to carry power and communication stations to the Moon. ⌘

NASA Announces New Nova Requirements

NASA HAS LAID DOWN one requirement governing its Nova launch vehicle studies—proposals by General Dynamics/Astronautics and The Martin Co. must be on a "time-competitive" basis with the space agency's current crop of liquid engines.

The space agency will not accept any proposal for the use of large solid motors or the development of new liquid engines unless they can be mated into stages in the same time period as the current F-1, M-1 and J-2 engines, informed sources disclosed.

It was also learned that the space agency will very likely initiate further studies of Nova once the current eight-month studies by the two firms are completed.

The follow-on studies will probably be opened to all firms wishing to bid.

Details of the contracts were revealed shortly after NASA announced the award to each firm of a $1 million contract for parallel studies of a Nova booster with two or three times the payload capability of the Advanced Saturn booster.

• **New liquid out?**—*The firms were told to study all possible propellant combinations, including solid, liquid, and nuclear engines. The "time-competitive" requirement would make the development of a new liquid engine almost impossible. It could also prevent the use of large solid motors, because neither NASA nor the Defense Department has yet begun serious development of them.*

The sources said that the use of 10 F-1 liquid oxygen/kerosene engines would give Nova twice the payload capability of the Advanced (C-5) Saturn. Twelve F-1 engines would give it three times the C-5 capability.

Hardware development of Nova will depend upon mission requirements, it was reported. If NASA decides it needs an operational vehicle in 1969-70, development will begin next year.

Current NASA thinking on Nova was revealed by Associate Administrator Dr. Robert C. Seamans, Jr., in a speech before the American Rocket Society in Cleveland.

Seamans said:

"We want to build a Nova powerful enough to carry out space missions of the early 1970's. These may well include transportation of heavy payloads of equipment to prepare for and maintain a manned base on the Moon. Nova may also be employed to lift very large objects into orbit for rendezvous and assembly into spacecraft for planetary exploration."

At ARS lunar meeting . . .

Revised Manned Flight Plans Outlined

NASA officials indicate contracts will soon be let on a number of major tasks in Project Apollo

CLEVELAND—The revised pattern of NASA's manned spaceflight program, including new projects on which bids will be asked, now is more clearly defined.

Last week's American Rocket Society meeting here on lunar missions, first since the space agency's major decision in favor of lunar-orbit rendezvous, gave industry and government officials an opportunity to spell out additional details of the program.

The following list of future vehicles proposed in NASA's manned spaceflight program was drawn from papers presented and from several well-informed participants:

—*The "Bug".* The announced *Apollo* lunar-orbit-rendezvous (LOR) ejection vehicle for which RFP's (Requests for Proposals) are expected this week from the Houston Manned Spaceflight Center, according to D. Brainerd Holmes, director of NASA's Office of Manned Space Flight.

—*Lunar Logistics Vehicle.* To be used to support manned operations on the moon. Will be launched atop the *Saturn C-5*. Systems group is studying the project under Dr. Joseph F. Shea in the Office of Manned Space Flight, Washington, D. C. RFP's are expected within the next few months.

—*Two-Man Apollo Craft.* Announced earlier this month. Under study and calls for sending two men directly from Earth to Moon. This is a back-up to the bug and possibly would be used to close the gap if Russia beat the U. S. to the moon. RFP's may come out within two or three months.

—*Twenty-or-More-Million-Pound "Super" Nova.* Two NASA study contracts, each for one million dollars, given to Martin and GD/Astronautics for study of booster for operations beyond the moon. RFP's may be announced in Fiscal 1964.

—*Six-Man Spacecraft.* Study out to Lockheed for 10-ton vehicle. Probably will set up a pattern for six-man vehicle, which will act as shuttle to Earth-orbiting space station. RFP's expected possibly by December.

—*Earth-Orbiting Space Station.* Station with capability up to 30 men, supplied by six-man shuttle. North American has study contract. RFP's expected possibly by December.

The two Astronauts landing on the moon in the first *Apollo* bug will stay about 24 hours, said Holmes. Carrying 200 lbs. of scientific equipment in their vehicle, the men are expected to collect soil samples for examination on Earth and to make as many visual observations as possible.

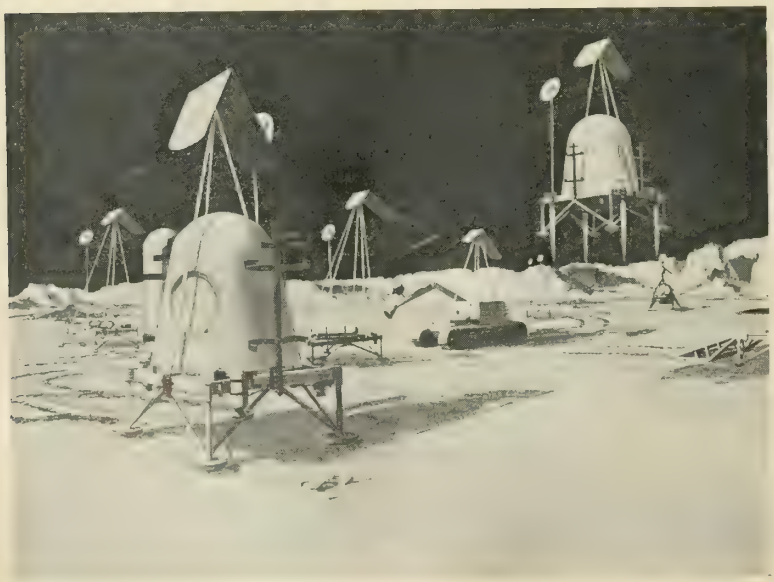
NASA is reported to be working closely with the Academy of Sciences and the scientific community to determine other scientific experiments to be made on the moon.

• **Adequate Astronauts** — In later flights, NASA hopes to send up an observer with scientific training, according to Holmes. He added that for the first flight the Astronauts "fill the bill."

Holmes said the 32 Astronaut candidates for the lunar missions began taking their physical examinations last week; although all are expected to pass because of the rigorous program of pre-selection, they will not all become Astronauts. The successful ones will be chosen before the end of August. Then first mission training will begin, followed by specific scientific training.

Holmes said there will be dry runs of LOR in Earth orbit in 1966. The bug will be separated from its mother craft first in tethered and then in untethered flights. He cited a Bell Aerosystems proposal for a simulated untethered flight at Edwards Air Force Base; he added that as yet the program has not been approved by NASA.

• **Belt-cleaning** — James A. Van Allen foresees the possibility of cleaning out the energetic particles belts surrounding Earth. This will permit high-altitude rendezvous of space vehicles or the spiraling of an electrically propelled vehicle on its way to the planets.



ARTIST'S CONCEPT of JPL scientists' proposal for lunar surface rendezvous utilizing tracked transport (center) to fuel return command module (foreground) with rocket motors. Manned module, landing at upper right, would not be committed until return module was fueled and ready for flight. Modified Surveyor (right rear) mounts TV cameras to provide monitoring from Earth of landings and operations.

The State University of Iowa scientist said this could be done by a series of suitably large nuclear bombs exploded at sufficiently high altitudes. He suggested—but took care not to recommend—that a 100-kiloton bomb be burst in the middle of an energetic particles belt to see what would happen.

He theorized that "magnetic bubble" is formed when the burst occurs. The geomagnetic field is distorted, bending the belts and causing protons to be dumped into the Earth's atmosphere.

Observing that the nuclear explosions could put into the belts fresh particles generated by fission decay—beta-radioactive particles and electrons—he warned that such particles may be worse than the ones knocked out.

He predicted that the current Johnston Island shots, because of their low altitude, will have negligible effect on the trapped particles in the radiation belts. "It will be barely discernible and of the order of one or two percent." He prefaced his remarks by noting that little data have come in from the observing stations and none from the orbiting *Injun 1* satellite—but he expected the analysis will be confirmed.

Joshing those who would keep the radiation belts intact for historical reasons, Van Allen said he does not subscribe to the archeological view—held by some scientists such as Sir Bernard Lovell—that like ancient pottery, the belts should be kept for their sentimental value.

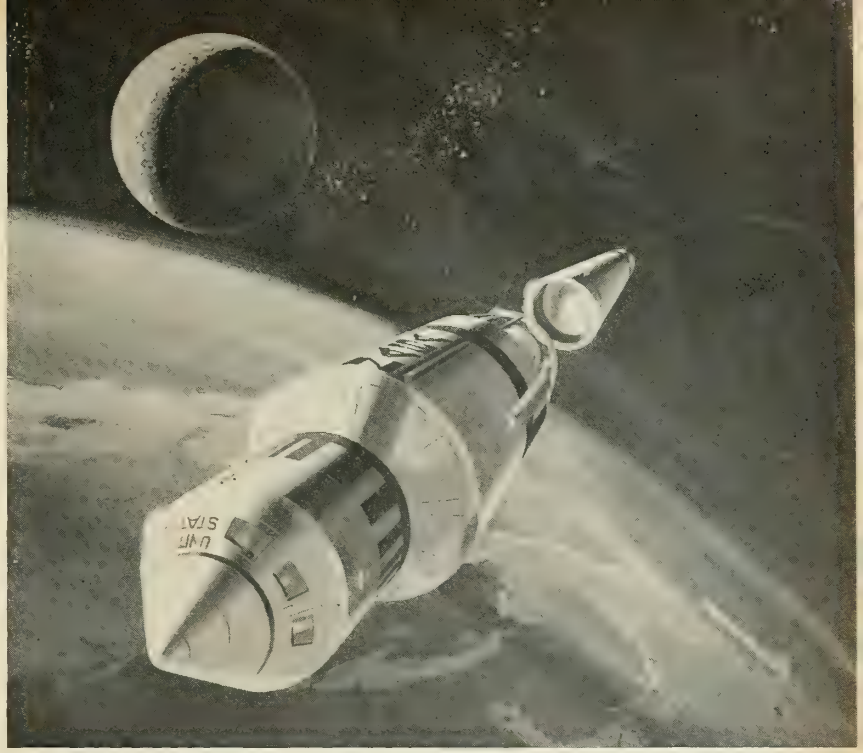
• **LOR limitation**—Ending some of the speculation about possible sites for the first manned lunar landing, Dr. Shea disclosed that the choice of LOR limits the initial landing to a belt within 10° of the lunar equator. Explaining that the areas that can be easily reached by unmanned vehicles such as *Ranger* and *Surveyor* lie on the leading quadrant of the moon, he concluded that the initial lunar landings will be bounded by lunar latitudes of ± 10° and by longitudes from 270° to 360°.

• **Safety and versatility**—Two concepts advanced at the ARS meeting stress safety and versatility in future space efforts (see accompanying photos).

John Small and Walter Downhower of Cal Tech's Jet Propulsion Lab presented a detailed study highlighting the inherent safety in establishing the reliability of mission elements before committing a manned module to a lunar landing.

They foresee the manned landing being made with the aid of previously landed guidance beacons and television monitoring equipment to provide safety margins comparable to those for aircraft on Earth.

Ted J. Gordon, chief *Saturn* systems engineer for Douglas Aircraft's Missile and Space Systems Division, envisions future launch vehicles doubling as spacecraft. His technical paper on the *Saturn S-IV* rocket detailed how booster rockets may be used as Earth-orbit tankers, or, when expended, may be useful as space laboratories or way stations for lost space travelers.



S-IVB SATURN STAGE in artist's drawing approaches space tanker already in Earth orbit. After propellants in tanker are transferred to S-IVB, rocket will launch spacecraft into space. Tanker concept of dual-purpose rocket stage—both vehicle and spacecraft—was proposed at ARS Lunar Missions Meeting by Douglas scientists. Author also suggested use of expended boosters as laboratories, first aid stations.

The JPL study is based on use of a *Saturn* booster with a lunar injection capability of 30,000 lbs. This weight would allow an immediate start on developing mission elements.

Mission reliability is enhanced in this concept, the authors noted, because assembly and checkout techniques can be developed under easily controlled conditions on Earth, and in Earth orbit.

The lunar surface rendezvous mission would be accomplished in eight steps:

1. Site selection and survey by *Ranger* and *Surveyor* spacecraft.
2. Beacon equipment landed on the selected site.
3. Three spacecraft landed, each carrying one solid-propellant motor and equipment to transfer the motors to the return command module.
4. Return command module landed.
5. Rocket motors emplaced on return command module.
6. Checkout of return module through television and telemetry.
7. Landing of manned capsule.
8. On completion of exploration, launch of return capsule Earthward.

The mission would call for at least five successful *Saturn* launches—to land three rocket motors and assembly equipment, the return command module, and the manned *Apollo* module.

To illustrate the Douglas concept, Gordon described proposed missions for the upper stages of *Saturn*.

Some *Saturn C-5* missions, he said, will require that the *S-IVB* third stage function for hours or even days after separation from the lower stages.

He said an *S-IVB* might rendezvous with a tanker previously placed in Earth orbit, take on its propellants and then blast a spacecraft to escape velocity.

On the other hand, he said, the *S-IVB* could be fueled prior to takeoff from Earth and be fired into parking orbit, where it would remain until precise trajectory data and launch time were computed. Then it would be ignited to send the payload deep into space.

S-IV, the second stage of the *Saturn C-1*, ignites immediately after cutoff of the first stage and operates without orbital storage or coasting techniques. But even here, Gordon noted, the stage could be put to use as a first aid station, beacon—or even space laboratory. ⌘

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- ... Closed Ecological Systems
- ... Guidance for Orbital Rendezvous
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Technical Countdown

ELECTRONICS

Phony Paper Results in WESCON Panel

Intrigued rather than angered by a hoax paper submitted for screening and possible inclusion in the WESCON program next month in Los Angeles, officials have invited the paper's authors to participate in a special panel on technical program selection procedures. Why? The authors revealed their technical abstract and summary was a hoax *after* it had been accepted for presentation. The new panel session is titled: "Can a Foolproof Method be Devised for Selecting Valid, High-Quality Technical Papers for Major Technical Conventions?"

Air Force Loses NMCS R&D Role

Defense Secretary McNamara has placed responsibility for the National Military Command System in the hands of Dr. Harold Brown's DDR&E. This office will establish a technical support group to be in charge of the design and development of NMCS. Systems engineering and technical supervision will be provided by the Defense Communications Agency, which also will create a new organizational element. Still a major question is to what extent AFSC's Electronic Systems Division at Hanscom Field will take part in developing the national command system.

No Room for the Crew?

Over two tons of electronics reportedly must be installed aboard *Polaris* submarines to check out a missile launch during the Navy's System Installation Test and System Development Analysis. Excluding missileborne telemetry, about 2000 lbs. of extra telemetry gear must be carried. This includes 22 separate pieces of equipment which must be squeezed through a 28-in.-dia. hatch. Another ton of equipment, insiders say, is required for temporary checkout, timing and control, digital recording, and communications subsystems.

Project Relay Southern Terminal Ready

ITT reports development of a universal air-transportable radio station for satellite communications. To be used initially as the South American ground station supporting NASA's Project *Relay*, the four-van system is capable of handling up to 12 voice and 12 teleprinter circuits at one time. A 30-ft. steerable, paraboloidal-reflector antenna and a 10-kw FM transmitter are included in the mobile terminal.

Lunar TV Program Described

Rangers 6 through *9* will each carry six TV cameras to provide a close look at the lunar surface in preparation for future manned landing, according to JPL. Cameras, built by RCA, will be slow-scan, high-resolution units. The first of this new *Ranger* series is expected to be launched in 1963. Weighing 350 lbs., the TV payload will consist of two wide-angle and four narrow-angle cameras, a control programer and camera sequencer plus telemetry and power supply. JPL will record transmissions on 35-mm film.

ADVANCED MATERIALS

Coating Enhances Carbide Nozzles

A layer of tantalum carbide on 90% tantalum-10% tungsten alloy drastically extends the effectiveness of the alloy in rocket nozzle applications, say scientists at National Research Corp. Developed under a Navy contract, the layer provides a surface melting point within a few hundred degrees of any known material and higher than any known element.

Integrated Chromium Alloy Program Under Way

A group of coordinated research projects at Battelle Memorial Institute is aimed at a better understanding of the effects of alloying chromium, molybdenum and tungsten with other metals—particularly rhenium. The refractories are plagued with low-temperature brittleness, but alloying with about 30-35% Re overcomes this and improves high-temperature strength. Participants include Chase Brass and Copper, General Electric, Pratt & Whitney, Office of Naval Research and the Air Force Aeronautical Research Labs.

Foam Metals and Ceramics Developed

Astro Met Associates has perfected a process for preparing foam metal and ceramic structures having continuous open cells—resulting in low densities but relatively high strengths. Zirconia, alumina, nickel, copper tungsten and other refractory materials are being manufactured in nominal cell diameters of 10, 20, 50 and 80 thousandths of an inch with densities ranging from a low of 2.5 to over 15% of theoretical. Porosities range from 97.5 to as low as 85% in these pore sizes.

New Technique for Free Radical Fuel Studies

A method which cuts the frequency of molecular collisions and reduces impact energy almost to zero through freezing is being used by the Thornton Research Centre of Shell Research Ltd. to probe free radicals and the combustion of fuels. The British scientists use the surface of a drum revolving in a vacuum and cooled to liquid air temperatures. One of the reactants is sprayed onto the drum and another nozzle then adds an atomic free radical such as sodium. These atoms bombard the frozen molecules and convert them to free radicals. The drum brings these before another aperture which introduces molecules of the second reactant. The frozen structure of the immobile radicals can be removed and studied.

Plastic Nose Cone/Nozzle Press Operational

A 2500-ton press with platens 72 in. by 96 in. and 96 in. of daylight has been installed at Haveg Industries to handle large, complex plastic cones. The huge press, added to many other smaller ones at the firm's three plants, gives Haveg the capability of handling the largest exit and nose cones presently being designed by missile/space companies.

SPACE MEDICINE

Long-term Radiation Study Planned

UCLA scientists hope to learn much about long-term exposure to radiation in a series of studies at the AEC's Nevada Test Site. Program will involve exposure of small desert animals in their native habitat to continuous, low-level radiation from a specially "planted" source to determine effects upon successive generations—a technique impossible to duplicate in laboratories or through single-animal analysis.

'Greencheese' Vehicles Proposed as Moon Samplers

Sperry Gyroscope officials tell House Space group lunar material can be more economically analyzed on Earth than on Moon; water landing envisioned

by Charles D. LaFond

GREAT NECK, N.Y.—Lunar surface samples can be brought to Earth and analyzed more easily, more efficiently and at considerably lower cost than they can be studied on the Moon.

This was the crux of a proposal described recently by a Sperry Gyroscope team at an informal briefing for the House Space Committee. The Committee is exploring alternatives for launching space vehicles such as NASA's *Surveyor* and *Prospector* if the *Centaur* space booster is inadequate.

Sperry embarked on a company-sponsored program about a year and a half ago at the suggestion of NASA scientists concerned with the overcomplexity of lunar research vehicles now in development.

The company made its first formal proposal, called Project *Greencheese*, in mid-1961. Its purpose was to build a small prototype vehicle capable of obtaining lunar samples and returning to Earth.

Reportedly, response was enthusiastic, but the project was never funded.

Sperry continued its studies and feels now that the project is not only feasible but one that could be used to advantage in a program such as *Surveyor*.

• **Design considerations**—Simplicity and reliability are the chief characteristics of the proposed *Greencheese* lunar vehicle. Only two major tasks have been considered for the craft: collection of lunar surface material and its safe return to Earth. Thus, only those subsystems that contribute directly to these objectives have been included in the initial Sperry design.

Three assumptions were made to permit design simplicity: a parent vehicle will safely land the *Greencheese* capsule, eject it onto the lunar surface, and serve as a communications relay to the capsule for commands from the Earth control station through initiation of the return phase.

All subsystems within the capsule, the capsule and return vehicle structures, and the techniques to carry out the mission are well within the present state of the art, Sperry engineers assert.

Once ejected from the parent vehicle, the lunar capsule must be capable of:



PROJECT Greencheese could employ a lunar landing vehicle with this spherical configuration, according to Sperry Gyroscope Co.'s proposals. Three curved legs adjust and level the vehicle before a helical conveyor (bottom center) is lowered to obtain terrain samples. Complete capsule would weigh about 175 lbs., with 44-in.-dia. shell.

self-deployment and erection regardless of terrain, adequate sample collection and stowage, return launch, re-entry, and safe water landing for recovery by tracking vessels. In addition, the system must be small and light enough to be easily carried by the parent vehicle.

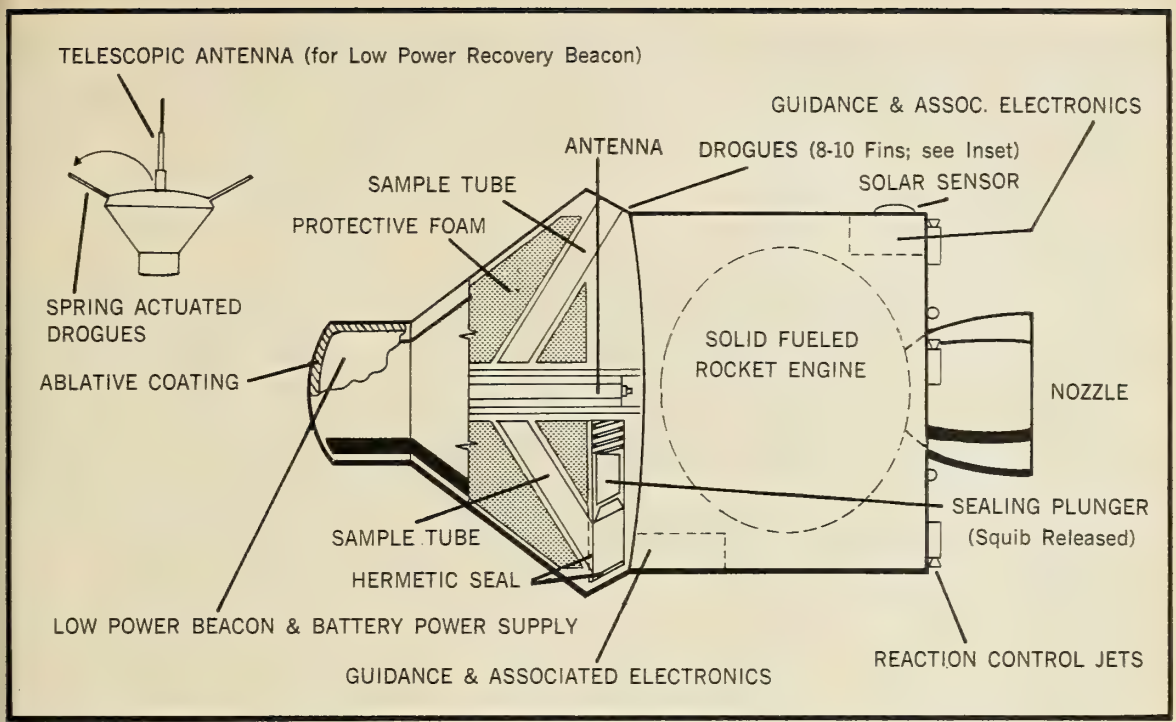
• **Jack-in-the-box construction**—The complete package, according to Arthur A. Lambert, technical manager of Space Programs in Sperry-Rand's Systems Group, will weigh about 175 lbs. The outer shell will be a 44-in.-dia. sphere (see photo of mockup).

With this configuration, the parent vehicle would need only to lower a semi-rigid slide or pair of rails to eject the landing capsule.

After rolling to a stop, Lambert declared, the sphere should be situated within 90° of the system's vertical, since the craft is designed with its center of mass on the desired vertical axis and below the geometric center. If not so situated, because of unusually rough or soft terrain, tangentially located reaction jets along a perimeter of the sphere would be fired automatically in sequence until the 90°-or-better condition was attained.

The three curved legs would then swing down independently from the shell to complete erection by assuming a nearly perfect vertical alignment. Pendulum devices will be employed to control the motors driving each leg.

At the center of the sphere is the return vehicle and rocket-motor assembly. Positioned vertically but with its blunt re-entry nose down, the vehicle would be ready to receive the lunar samples. Surrounding this system is the equipment necessary to obtain the geological samples, but which will be left



POSSIBLE ARRANGEMENT of subsystems and lunar terrain sample storage sections in Greencheese return vehicle.

behind after launch: the leveling devices, leg motors, battery, timer and the sample collectors. The latter consist of a low-speed helical material conveyor for picking up dust or very soft terrain, and a high-speed small-bore drill for hard pan. The drill will be capable of obtaining samples from extremely hard terrain to a depth of about 1 ft.

A sequence control unit (a clock), activated before launch from Earth, controls all the subsequent start-stop operations of the various subsystems.

The terrain samplers would be lowered and collected materials dumped into separate storage tubes in the re-entry vehicle. Squib-actuated valves then would close each compartment with a double seal—one being a meltable alloy that effects a hermetic seal after solidifying. The drills would next be retracted.

• **Initial return phase**—Before initiating the return launch, the lunar vehicle must be located. To do this, Lambert proposes that NASA's Deep Space Instrumentation Facility (DSIF), operated by the Jet Propulsion Laboratory, be employed to obtain a fix on the parent carrier. This, he said, can be accomplished to an accuracy of about one mile. Data then would be fed to ground control where either initial launch heading or required velocity would be computed.

These are the prime variables, one of which must be calculated depending on system design. For example, Lambert continued, in a system designed for fixed terminal velocity, position errors (based on impact area requirements) can be minimized by adjusting launch azimuth and elevation. Conversely, with a fixed-launch azimuth and elevation system, velocity corrections may be used for position error compensation.

The fixed-launch orientation system is preferable, Sperry engineers believe, because of the simplicity with which cutoff velocity could be varied electronically as a function of position. Programable launch angles, they say, would depend on the use of accurate mechanical boresights and servo systems.

Velocity cutoff information would be transmitted to the carrier vehicle and then relayed by low power radio to the *Greencheese* guidance system.

The desired azimuth angle between the solar line of position and the preset launch azimuth would have been programed before original Earth launch. Thus, said Lambert, upon a signal from the sequence control unit, the upper hemisphere of the lunar craft would be blown free and the complete return vehicle would be rotated in an azimuth gimbal mount. Rotation would continue until a solar sensor locates the Sun.

A second motor would then rotate the vehicle about a horizontal axis to programed launch elevation (accomplished with simple mechanical stops). Leg motors would be energized, raising the whole vehicle about 12 in. above the lunar surface. The sectionalized lower hemisphere would be dropped off in pieces, leaving only the main support ring and leg assembly. This should minimize rocket exhaust back-blast during lift-off, Lambert said.

• **Return vehicle**—Two main subsystems comprise the return system: a high mass-fraction solid-propellant rocket motor and the re-entry vehicle.

Aerojet-General Corp., consulted by Sperry more than a year ago, has indicated that the return-rocket requirements for *Greencheese* would offer no design problems either in size or thrust.

The propulsion system envisioned would be from 18-23 in. in total length, including the nozzle, and approximately 13 in. in diameter. Total impulse required would be from 16,000-22,000 $lb._f$-sec. with a specific impulse of 285 $lb._f$-sec./$lb._m$, according to Sperry. The motor would provide an average thrust of 650-900 $lb._f$ and an average pressure of 300 psia for a total action time of about 25 sec. These performance ranges, they stressed, would vary with the application.

The re-entry vehicle, looking and functioning aerodynamically much like a badminton bird, would carry a velocity computer, autopilot, reaction-jet attitude control system (or spin jets), a tracking transponder and a low power beacon with a telescopic antenna (for recovery).

Various control systems could be

(Continued on page 26)



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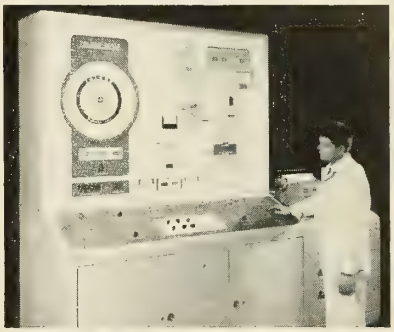
Bristol, Pennsylvania

ROCKET OPERATIONS CENTER: Ogden, Utah

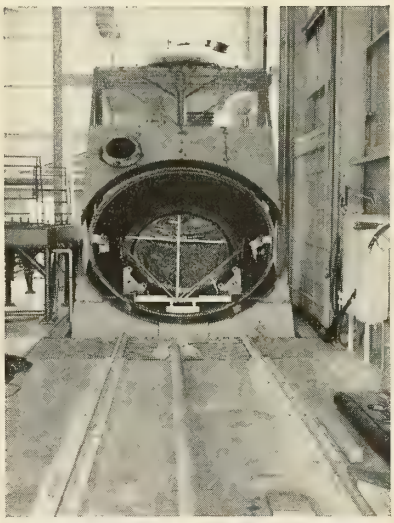
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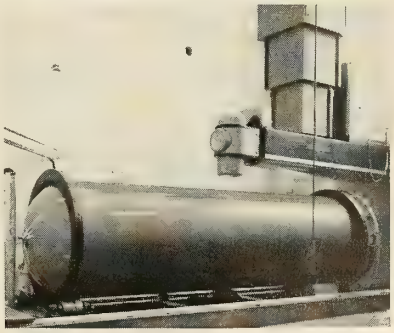
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Project Greencheese

(Continued from page 23)

employed, Sperry engineers claim. For a programed launch system, they contemplate using a two-degree-of-freedom gyro to control pitch and roll and a rate gyro for yaw control. The former together with an autopilot will be used to maintain the vehicle thrust vector in the direction of the gyro spin axis. By programing the spin axis as a function of velocity, Sperry designers feel any desired final velocity and direction could be achieved.

The velocity computer, integrated with the autopilot, would continuously compare the actual velocity with programed cutoff velocity.

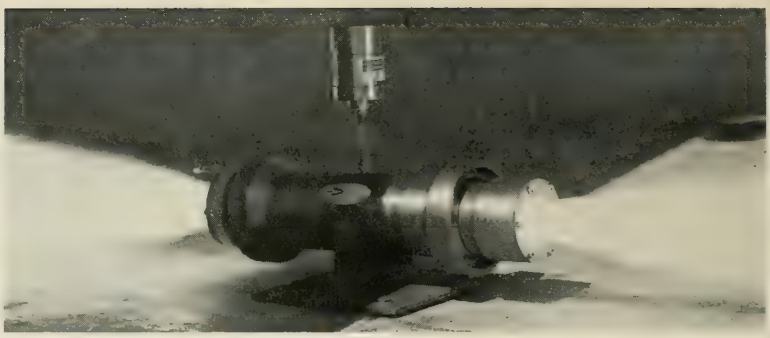
The transponder, compatible with DSIF tracking systems, would be activated at launch. The metalized outer shell of the re-entry vehicle would serve as a radiating surface for the high frequency beacon antenna.

The return vehicle structure will employ several ablative materials to conserve weight, varying with heat resistance requirements over the outer surface during re-entry.

Synthetic quartz will cover the blunt nose, which is expected to experience a peak heating rate of about 2200 BTU/ft.^{2} sec. The nose cylinder and broad frustrum section will employ chrysolile asbestos cloth with a phenylsilane binder.

The inverted frustrum at the rear and the back bulkhead will require only a phenolic impregnated asbestos mat, according to Sperry.

If sterilization is deemed necessary after lift-off, designers say the entire vehicle could be coated with a self-oxiding combustible material that would effectively decontaminate the structure upon ignition.



UTC's 'Janus' Test Motor

UNIQUE TWO-HEADED midget rocket motor is fired at United Technology Corp.'s Sunnyvale, Calif., development laboratory. Motor fires simultaneously from both ends to test new nozzle designs. It's named "Janus," after the ancient double-headed Roman god.

• **Small impact area predicted**—Designers feel that because of the technical sophistication of JPL's DSIF and the long travel time of the return vehicle, impact prediction can be reasonably accurate—within a five-mile radius.

Errors attributable to unpredictable events occurring during re-entry will be minimal, they say, because of the 90° re-entry angle and high vehicle velocity.

The overall target zone at sea would be an ellipse 2200 miles long by 550 miles wide. With three recovery ships spread out over the long axis and given a speed of 20 knots, at least one vessel could reach any point in the ellipse within 24 hours, engineers say.

Once within the five-mile DSIF-predicted impact area, ships would effect recovery by tracking the low power c-w beacon carried in the re-entry vehicle.

• **Re-entry conditions**—The *Greencheese* return vehicle is designed to re-enter the Earth's atmosphere at 90° and at a velocity of 35,000 ft./sec. The re-entry body's ballistic coefficient is 20.

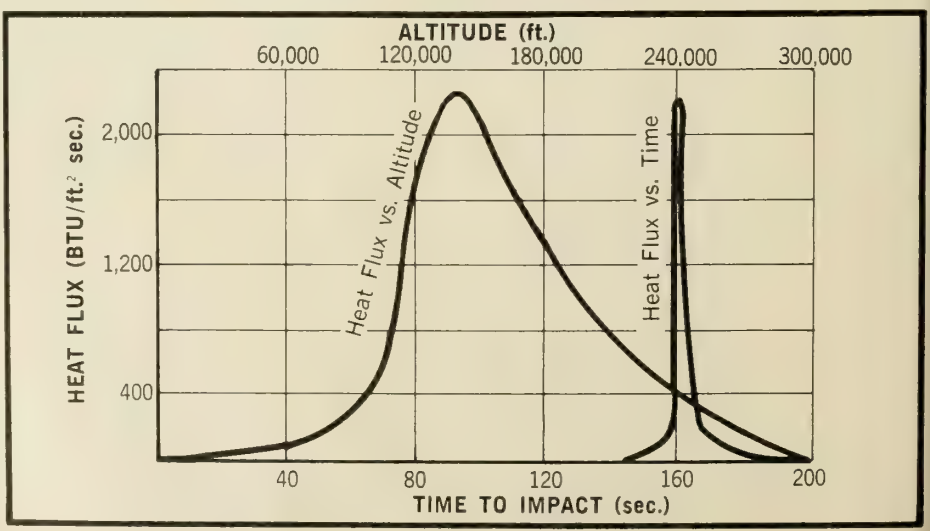
Designers say maximum calculated deceleration of 300-g would occur at 120,000 ft. at a velocity of 22,000 ft./sec. Maximum heat flux would occur at 135,000 ft. (see the accompanying heat flux curves).

Flight time from re-entry at 300,000 ft. to terminal velocity (300 ft./sec.) at 50,000 ft. would be about 12 sec.

At 50,000 ft., drogues could be unfolded to extend outward from the circumference of the vehicle's rear bulkhead. They would increase aerodynamic drag and further decelerate the vehicle. With the drogue device, Sperry designers estimate an impact velocity of less than 150 ft./sec.

Design details of the *Greencheese* vehicle as described are preliminary. However, Sperry project leaders feel they have proved feasibility of the use of such a vehicle for the recovery of lunar geological samples.

The principal points claimed by advocates in their proposal are that the vehicle is simple in design, practical in its operation, and of considerably lower cost than comparable approaches presently contemplated. ⌗



ESTIMATED heat flux variations are shown as functions of altitude and time to impact that Greencheese return vehicle would encounter with planned 90° re-entry angle.

Saturn Radar Altimeter in Production

Instrument built by Ryan Electronics doesn't begin evaluating return data until it's 50 km up

by Arthur H. Collins

SAN DIEGO—Ryan Electronics has begun to assemble production models of its high-altitude radar altimeter for the *Saturn* vehicle. A prototype of the unit is now undergoing airborne flight testing.

Under a contract from NASA's Marshall Space Flight Center, Ryan will build a total of 10 altimeters for the program. The altimeters will be carried in the *Saturn* instrumentation unit, located generally below the payload package.

Although based on conventional radar altimetry, the Ryan approach is unusual in that the instrument does not begin evaluating radar return data until the vehicle is about 50 km above the Earth's surface, and it continues to produce altitude data for the telemetry system to approximately 400 km with a system accuracy of ±30 meters.

In compliance with NASA's design specifications of simplicity and interchangeability, Ryan has designed the 25-lb. altimeter in five basic modules: timer, modulator-power supply, receiver, IF amplifier and range tracker. The modular approach provides easy exchange for circuit modification or for changes resulting from prototype testing. The complete package measures 9¾ x 9x11½ in.

• **Time measurement**—Like most radar systems, the altimeter depends upon accurate measurement of the time lapse between a transmitted pulse and the echo. For *Saturn*, time measurement begins at the center of the transmitter pulse and continues to the center of the return echo. This is accomplished by inserting a 0.5-microsecond time delay into the path of a "sample" transmitted pulse, and sensing the exact center of the return pulse.

The transmitter is a pulsed re-entrant cavity keyed to transmit a 1-microsecond pulse at 1610 mc. The pulse is transmitted to a customer-furnished planar array antenna through a solid-state duplexer. Transmitter output power is 5 kw with a repetition frequency of 144 pps. When the transmitter is triggered, a sample pulse is sent to the range tracking section as a time standard. This pulse opens a range tracker gate circuit. A processed Earth-return signal closes the gate to determine absolute altitude.

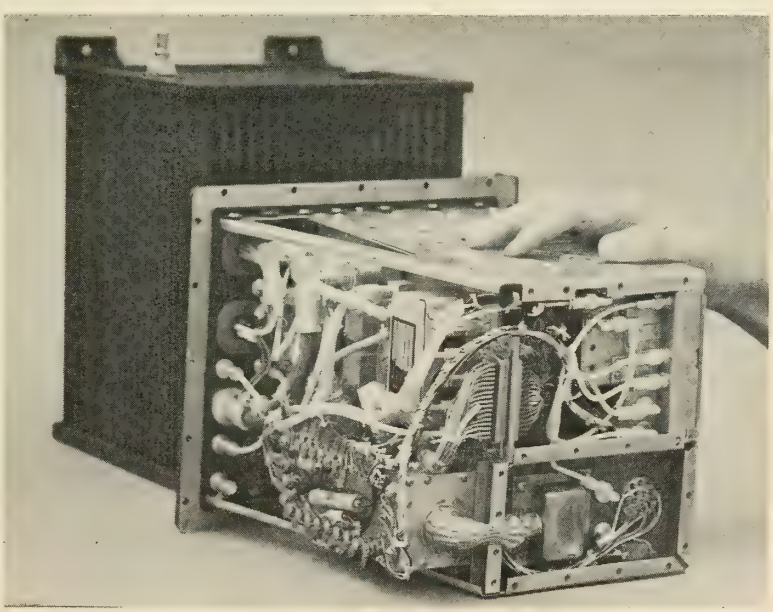
An Earth-reflected signal received by the antenna is passed to the altimeter's receiver section, which consists of an antenna duplexer, a mixer-local oscillator and an IF amplifier. The crystal mixer receives the pulse and beats this signal with a 1580-mc signal from the local oscillator. The resulting 30-mc mixer output includes both random noise and the return echo. This signal is passed on to the IF amplifier and video detector circuits.

The IF amplifier is a two-tube-plus-transistor hybrid circuit with an overall gain of 109 db and a 3-mc bandwidth. It also receives an AGC signal fed back from the range tracker for signal improvement and control.

• **Two-purpose pulse** — Although the radar transmitter is turned on at launch, altitude evaluation is not immediately effected, due to an internally generated 100-microsecond blanking pulse. The pulse serves two purposes. It protects the receiver from the relatively high energy signal it would receive at "low" altitudes below the system's design parameters. It also acts as a key to the system's actual operation in that the 100-microsecond value is a radar altitude equivalent of the 50-km "turn-on" point.

Because of the delay in altitude evaluation, the system must search for the reflected pulse. This has necessitated a two-mode operational configuration. A "search" mode locates the return signal and separates the echo from the noise. The system then switches to a "track" mode that locks on to the return pulse and tracks it until system design limits are reached.

When the echo is picked up in the



ASSEMBLED ALTIMETER measures 9¾ x 9 x 11½ in. and weighs 25 lbs. Its five basic modules include timer, modulator-power supply, receiver, IF amplifier and range tracker. System is designed for solid mounting in vehicle, and completely pressurized.

search mode, it is passed through the receiver to the range tracker for processing. The range tracker separates the returned signal from its surrounding noise, and superimposes a pedestal-type signal over the return pulse. The two pulses then act in coincidence to close the range gate opened by the sample transmitter pulse. The gate is equal in time to vehicle altitude.

IF-amplifier output is fed directly to the range tracker's high-speed switch and voltage storage circuit. The track samples the storage circuit's average d-c voltage to determine which way an error servo must be driven to superimpose the tracker's pedestal signal over the return echo. If vehicle altitude, as related to time, is higher than a sample point, storage circuit output is a negative d-c voltage. If true altitude is lower than the sample point, output is a positive d-c voltage. The output voltage determines which way the error servo must be driven to superimpose the pedestal over the echo pulse.

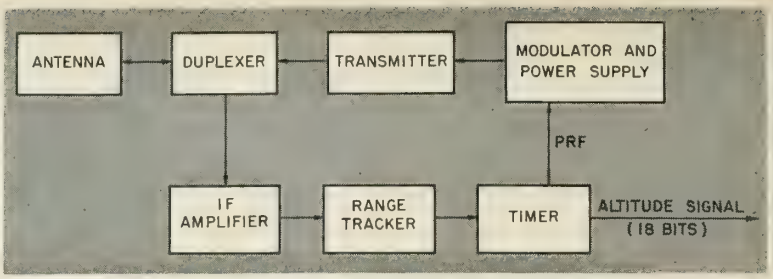
When the two signals are superimposed and average storage circuit output is zero, no error exists and the servo is stopped. Center of the return signal is then determined and the range tracking gate closed.

Voltage sum of the return pulse and tracker pedestal signals, when in coincidence, also energize a mode-switching relay to initiate "track" mode. If the return signal is ever lost, coincidence is also lost, and the tracker automatically returns to the search mode.

• **Reducing noise** — In the track mode, blanking pulses reduce noise around the return pulse to a 2-microsecond period with the return signal in the center. The error servo keeps the pedestal signal tracking the return echo as altitude increases. AGC circuits then further define the return signal and improve echo pulse quality.

A noise AGC circuit regulates noise amplitude of the range gate pedestal signal to a 5-volt peak during search mode with changing IF amplifier characteristics. A pulsed AGC circuit regulates range-gate pedestal voltage to a peak of 10 volts during track mode when signal power varies from −56 dbm to −86 dbm.

A fixed AGC circuit output voltage controls peak noise to 6 volts during transition periods between search and track. Without the latter voltage, the IF amplified would saturate and the tracker would be very slow to achieve track mode or, at high altitudes, might not track at all. An AGC "or" gate permits only the most negative voltage to be delivered to the IF amplifier, thus allowing proper voltages to take over at the appropriate time and operating conditions.



BLOCK DIAGRAM shows workings of Ryan's Saturn altimeter design.

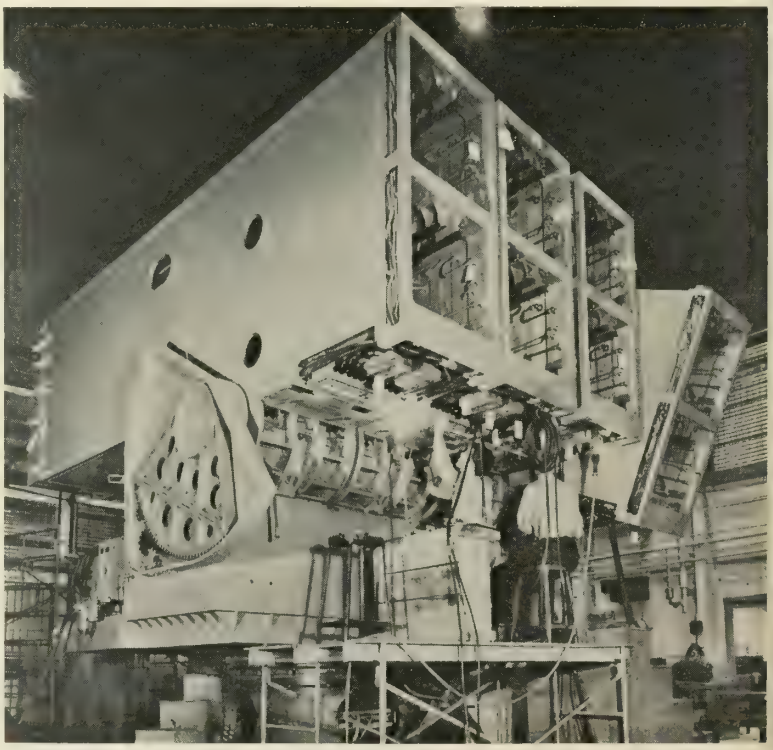
The range tracking circuit output is a gate with a length directly proportional to vehicle altitude. The output gate is sent to the timer circuit to provide a gate that furnishes clock pulses to a binary storage register. Register capacity is four of such gates containing the clock pulses—binary representations of altitude.

Binary storage is a reset circuit with a 36-pps reset rate. The register allows four gates containing the binary data to enter. Then, just prior to reset, dumps them into a storage register to await interrogation by the vehicle's telemetry system. Altimeter output to the vehicle's telemetry system is in 18-bit binary words at a 36 word-per-second rate.

An altimeter reliability output is also available for telemetry. Essentially a GO, NO-GO form, a 5-volt signal is transmitted when the altimeter is in track mode—a zero output if it is not.

The Ryan altimeter contains its own solid-state power supply receiving 28 volts dc at 80 watts from the basic vehicle system and supplying internal voltages for its own operations. Filters are used where necessary to minimize effects of transients.

The system is designed for solid mounting in the vehicle, and is completely pressurized at 5 psi above one atmosphere. ⁂



ASROC Launcher Readied for Delivery

LAUNCHER FOR Navy's ASROC antisubmarine missile nears completion at Universal Match Corp.'s Unidynamics Div., St. Louis. Launcher carries eight missiles in separate cells which are held in an over-and-under position within four guides automatically elevated and depressed through 85° to maintain constant 45° firing angle.

Opportunities for:

Aerospace Vehicles Engineers

The Aerospace Vehicles Laboratory of the Space Systems Division has openings for nearly one hundred engineers who have experience in stress, structures, propulsion, mechanisms, control systems, equipment installation or heat transfer which can be applied to advanced aerospace weapons systems or vehicles. The Aerospace Laboratory is concerned, as a result of SURVEYOR and other contracts, with lunar and space exploration, air to air missiles and ICBM defense systems. The openings are for both junior and senior mechanical engineers, electronic engineers, physicists and aeronautical engineers. Some of the openings are described below:

Structures

Senior Dynamicist. Must be capable of performing advanced analysis in structural mechanics. Will be required to calculate response of complex elastic systems to various dynamic inputs including random excitation. Must be capable of original work in developing advanced analytical techniques.

Loads Analyst. To establish structural design criteria for advanced missiles and spacecraft. Should be capable of determining external airload and inertial force distributions.

Reliability Analyst. To perform statistical analysis of structural loads and strength properties for the purpose of establishing structural reliability criteria on a probability basis.

Stress Analyst. To perform advanced stress analysis of complex and redundant missile and spacecraft structures. Will be required to solve special problems in elasticity, plasticity, short time creep and structural stability.

Design. Experience is required in preliminary and final structural engineering and design, including preliminary stress analysis. A knowledge of the effects of extreme temperature environment and hard vacuum, plus a background in materials is desired.

Heat Transfer

Space Vehicle Heat Transfer. Basic knowledge of radiation conduction and convection heat transfer with application to thermal control of space vehicles is required. Knowledge of spectrally-selective radiation coating, super-insulations and thermal vacuum testing is of particular value.

Aerothermodynamicist. Experience in hypersonic real gas dynamics, heat transfer, abalation; re-entry vehicle design, detection; shock layer, wake and rocket exhaust ionization; and anti-missile system requirements will be most useful.

Equipment Installation

Packaging and Installation Engineer. To perform optimum packaging and installation design for missile and/or spacecraft units, considering amount and geometric shape of space available as well as weight and center of gravity distribution requirements. Must be capable of analyzing structural adequacy of unit under extreme environmental conditions.

Controls

Optical Devices. Design, development, procurement and test operations are involved. Considerable experience in the field of optical devices for space applications such as star, horizon, sun and moon trackers.

System Test. To plan and supervise the operations of a flight control system laboratory. Air bearing tables and a wide variety of optical mechanical and electrical equipment are involved.

Control System Analysis. Requires engineers at various levels of experience including senior men capable of taking over-all project responsibility in the synthesis and analysis of control systems.

Circuit Design and Development. Experience in design and development of transistorized control system circuits, including various types of electronic switching and modulation techniques is required.

If you are a graduate mechanical engineer, electronic engineer, physicist or aeronautical engineer, with experience applicable to the above openings, please airmail your resume to: **Dr. F. P. Adler,** Manager, Space Systems Division, Hughes Aircraft Company, 11940 W. Jefferson Blvd., Culver City 79, California.

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Mariner I Poised for Venus Shot

Program aimed at interplanetary exploration will extend through 1965; six experiments on first flight

THE U.S. BEGINS its first serious interplanetary exploration program with the scheduled launch of the *Mariner I* spacecraft.

Prime purpose of the first flight—slated for no earlier than July 21—is to fly within 10,000 miles of Venus and make infrared and microwave measurements of the planet's temperature and surface.

It will be the first of 12 launches planned in the *Mariner* program to obtain data about Venus and Mars.

The second *Mariner* launch is scheduled for early August. Two launches were scheduled this year, NASA said, because of the difficult nature of the mission.

This is primarily attributable to the long life of the flight, extending up to 140 days. The spacecraft will also be subjected to prolonged variations in temperature and unknown amounts of interplanetary radiation.

Two more flights toward Venus will be made in 1964. In 1964 and 1965, eight flights using a heavier advanced *Mariner* spacecraft will be made to the vicinity of Mars and Venus. It is probable that the later spacecraft will contain a capsule which will be injected into the atmosphere of both planets.

If successful, *Mariner I* will provide the first detailed information on Venus's atmosphere and surface temperature.

Data about both will go a long way toward establishing whether life on that planet is possible.

Six other experiments will be carried on the flight:

—An infrared radiometer experiment to provide information on the distribution of thermal energy in the planet's atmosphere.

—A magnetometer experiment to determine the three mutually perpendicular components of the magnetic field between Earth and Venus.

—A charged-particle experiment to detect the distribution, variations and energies of electrically charged particles in space and in the vicinity of Venus.

—An ionization chamber to detect the rate at which charged particles lose energy.

—A plasma experiment to obtain information on the extent, variations in, and mechanism of the solar corona.

—A micrometeorite experiment to measure the density of cosmic dust particles in interplanetary space and in the vicinity of Venus.

• **Configuration**—*Mariner I* weighs 446 lbs. and, in the launch position, is 5 ft. in diameter at the base and 9 ft., 11 in. high. In the cruise position, with solar panels and high-gain antenna extended, it is 16.5 ft. across in span and 11 ft., 11 in. high.

The hexagon framework base houses a liquid-fuel rocket motor, for trajectory correction, and six modules containing the attitude control system, electronic circuitry for the scientific experiments, power supply, battery and charger, data encoder and command subsystem, digital computer and sequencer, and radio transmitter and receiver. Sun sensors and attitude-control jets are mounted on the exterior of the base hexagon.

A tubular superstructure extends upward from the base hexagon. Scientific experiments are attached to this framework. An omnidirectional antenna is mounted at the peak of the superstructure. A parabolic, high-gain antenna is hinge-mounted below the base hexagon. Two solar panels are also hinged to the base hexagon. They fold up alongside the spacecraft during launch, parking orbit and injection and are folded down, like butterfly wings, when the craft is in space. A command antenna for receiving transmissions from Earth is mounted on one of the panels.

The solar panels contain 9800 solar cells in 27 square feet of area. They will collect energy from the Sun and convert it into electrical power at a minimum of 148 watts and a maximum of 222 watts.

• **Power supply**—Prior to deployment of the solar panels, power will be supplied by a 33.3-lb. silver-zinc rechargeable battery wtih a capacity of 1000 watt hours. The recharge capability is used to meet the long-term power requirements of the Venus mission. The battery will supply power directly for switching and sharing peak-loads with the solar panels; it also will provide power during trajectory correction when the panels will not be directed at the sun.

The power subsystem will convert electricity from the solar panels and battery to 50 volt, 2400 pps; 26 volt, 400 cps, and 25.8 to 33.3 volt d-c.

Two-way communication aboard the *Mariner* is supplied by the receiver/transmitter, two transmitting antennas—the omnidirectional and high-gain antenna, and the command antenna for receiving instructions from earth. Transmitting power will be 3 watts.

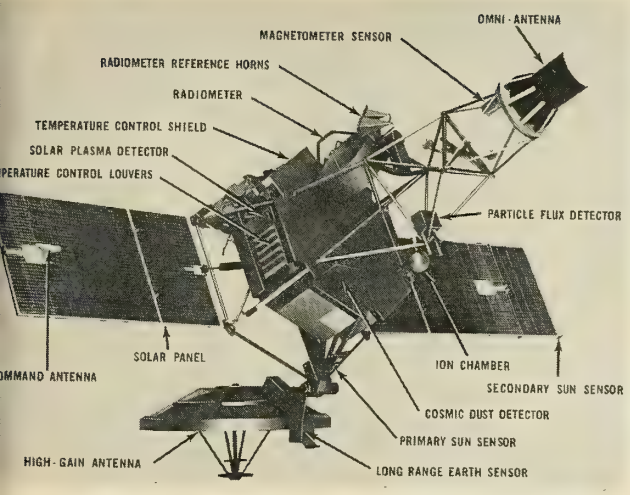
Stabilization of the spacecraft for yaw, pitch and roll is provided by 10 cold-gas jets, mounted in four locations, fed by two titanium bottles containing 4.3 lbs. of nitrogen gas pressurized to 3500 psi. The jets are linked by logic circuitry to three gyros in the attitude-control sub-system, to the Earth sensor on the parabolic antenna and to six Sun sensors mounted on the spacecraft frame and on the back of the two solar panels.

The four primary Sun sensors are mounted on four of the six legs of the hexagon, and the two secondary sensors on the backs of the solar panels. These are light-sensitive diodes which inform the attitude control system—gas jets and gyros—when they see the Sun. The attitude-control system responds to these signals by turning the spacecraft and pointing the longitudinal or roll axis toward the Sun. Torquing of the spacecraft for these maneuvers is provided by the cold-gas jets fed by the nitrogen gas regulated to 15 psi. There is calculated to be enough nitrogen to operate the gas jets to maintain attitude control for a minimum of 200 days.

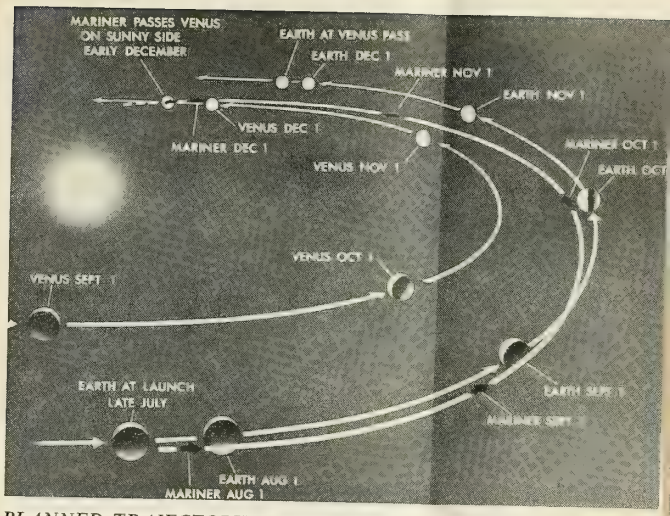
• **Venus fly-by mission** — Launch vehicle for the first *Mariner* shot is the *Atlas-Agena B*. It will launch the spacecraft to an Earth-orbit altitude of 150 miles.

Five minutes after launch the *Agena B* and *Mariner* separate from the *Atlas* booster.

The *Agena B* fires for the first time and burns for almost two and a half minutes to reach orbital speed of 17,450



MARINER I diagram shows interplanetary exploration gear.



PLANNED TRAJECTORY of Mariner I's long flight to Venus.

mph. After this burning time, *Agena B* shuts down and coasts in a parking orbit for more than 13 minutes until it reaches the optimum point in its orbit to fire for the second time.

The second *Agena B* burn injects the *Agena B* and *Mariner,* still as one unit, on an escape trajectory at a velocity of about 25,820 mph.

A little more than two minutes after second burn cutoff or injection, *Mariner* is separated from *Agena,* again by spring-loaded bolts. *Agena* then yaws 140-degrees in the local horizontal plane and performs a retro maneuver which reduces the *Agena* velocity and moves the *Agena* into a different trajectory.

Mariner now is on a trajectory that will take it fairly close to Venus. The omnidirectional antenna is working and radiating the radio transmitter's full three watts of power. Before and during launch, the transmitter had been kept at about 1.1 watts. This is required during the period the launch vehicle passes through a critical area between 150,000 and 250,000 ft., where a tendency exists for devices using high voltage to arc over and damage themselves; hence, the transmitter is kept at reduced power until this area is passed.

The sequence of events for *Mariner's* flight to Venus:

—The first command is issued by the CC&S 44 minutes after launch. Explosive pin pullers holding the solar panels and the radiometer in their launch position are detonated to allow the spring-loaded solar panels to open and assume their cruise position and free the radiometer to scan Venus as it passes by the spacecraft.

—At launch plus 60 minutes, the CC&S turns on the attitude control system and Sun acquisition will begin.

In order to conserve gas, the attitude control system permits a pointing error toward the Sun of one degree, or .5 degree on each side of dead-on. The mixing network in the attitude control system is calibrated to keep *Mariner* slowly swinging through this one degree of arc pointed at the Sun. The swing takes approximately 60 minutes. As *Mariner* nears the .5 degree limit on one side, the sensors signal the gas jets and they fire again. This process is repeated hourly through the effective life of *Mariner.*

—The Sun acquisition process is expected to take less than 30 minutes. When it is completed, the secondary Sun sensors on the backs of the solar panels are turned off to avoid having light from the Earth confuse them.

As soon as the solar panels are locked on the Sun, the power system will begin drawing electric power from the panels. The battery will now only supply power in the event of a peak demand that the panels cannot handle.

The next event initiated by the CC&S is the acquisition of Earth by the high-gain directional antenna. This does not occur, however, until 167 hours (seven days) after launch. The Earth sensor used to align the antenna is so sensitive that it would not operate properly if used earlier.

During Earth acquisition, the spacecraft maintains its lock on the Sun, but with its high-gain directional antenna pointed at a preset angle, it rolls on its long axis and starts to look for the Earth. It does this by means of the three-section, photo-multiplier-tube-operated Earth sensor mounted on and aligned with the high-gain antenna. During the roll, the Earth sensor will see the Earth and inform the gas jets. The jets will fire to keep the Earth in view of the sensor and thus lock onto the Earth.

The cruise mode will continue until time for the midcourse trajectory correction maneuver. After launch, most of the activity on the Venus Mission will be centered at the DSIF stations and at the Space Flight Operations Center at JPL.

• **Computer check**—Tracking data collected by the DSIF stations will be sent to JPL and fed into the 7090 computer system. The computer will compare the actual trajectory of the *Mariner* with the course required to yield a 10,000-mi. fly-by. If guidance errors before injection have put *Mariner* off the optimum trajectory, the computer will provide the figures to command the spacecraft to alter its trajectory.

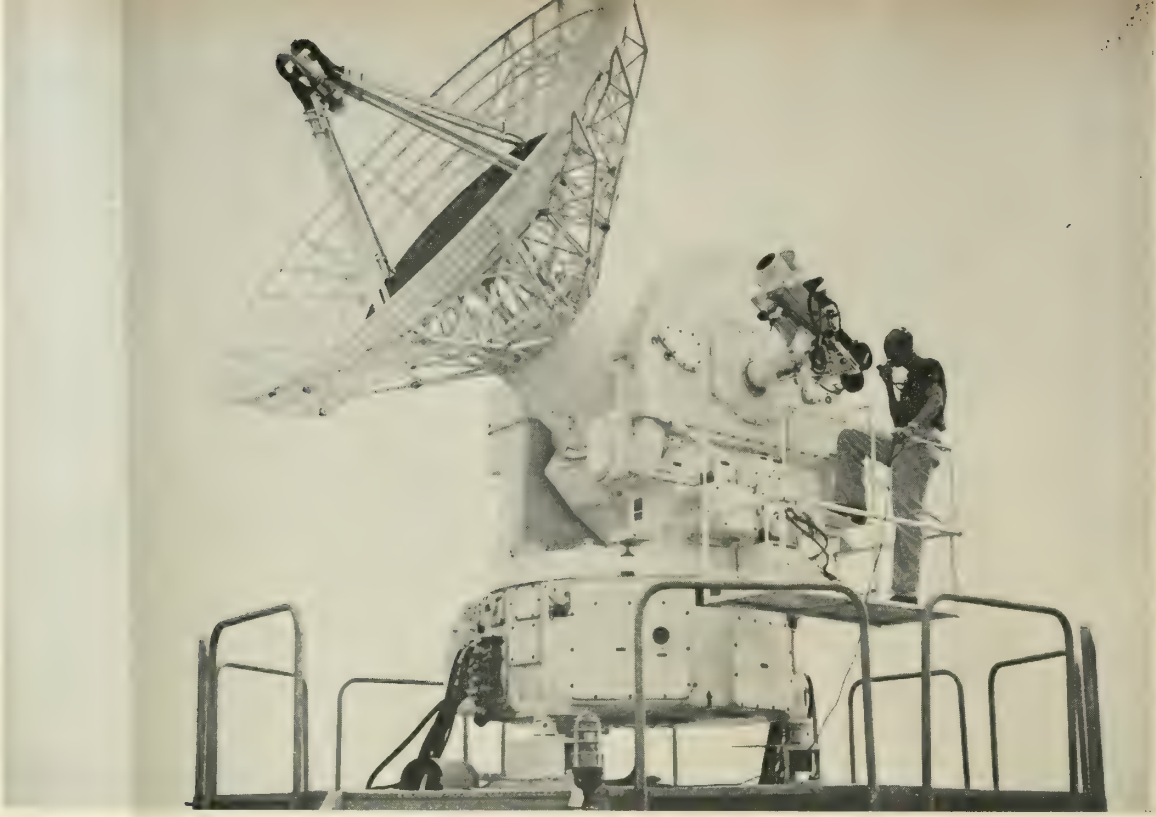
After the midcourse maneuver has put *Mariner* on the desired trajectory, the spacecraft again goes through the sun and earth acquisition modes.

Mariner will continue in the cruise mode until planet encounter. During this period, tracking data from the three permanent DSIF stations will be sent to JPL where the 7090 computer system will refine the earlier calculations for planet encounter made at launch.

Ten hours before planet encounter, the CC&S will switch out the engineering data sources, leaving on the interplanetary science experiments. During the fly-by, only scientific data will be collected and transmitted.

The radiometer will begin a fast-search scan until Venus is sensed and then go into a slow scan. The planetary experiments will collect data on Venus for ½ hour as *Mariner* passes the planet.

The encounter mode of transmission —scientific data only—will continue for 56.7 hours. At the end of this period, CC&S will switch on the engineering data sources, and again in the cruise mode, both engineering and interplanetary scientific data will be transmitted.



BASIC VERSION of RCA's FPS-16 now in use at some 50 missile range and tracking net locations.

space electronics

New Range Radar Claims High Accuracy

by Michael Getler

MOORESTOWN, N. J.—What could amount to a bargain-basement advance in missile range instrumentation radar is being claimed here at RCA's Missile and Surface Radar Division.

Engineers at the firm have combined coherent-pulse Doppler techniques with modified versions of RCA's FPS-16 and FPQ-6 monopulse tracking radars and come up with a low-cost radar instrumentation system which reportedly yields rapid (0.5 sec. smoothing time) radial velocity measurements accurate to 0.1 ft./sec. on missile/space targets having a minimum 6-db signal-to-noise ratio. Company officials claim this is the first successful application of coherent Doppler techniques to monopulse instrumentation radars.

According to RCA, the new system represents an improvement of almost two orders of magnitude over conventional time-vs.-position velocity measurement methods and is "at least equal in performance to advanced CW-type radar instrumentation systems now being developed by NASA and the Air Force, and at a fraction of the cost of any other such system."

Actually, what RCA has done is produce a modification kit for the widely used FPS-16 and for the newer FPQ-6. "By augmenting the performance of existing instrumentation radars as well as those in current production," a company spokesman said, "the considerable investment in precise pulse radar tracking facilities can be protected and utilized even more effectively."

At the heart of the system is the basic FPS-16 tracking radar, of which about 50 are now in service with various tracking nets around the world. RCA has modified one of these sets as a test vehicle by incorporating a 3-megawatt klystron-amplifier output tube, replacing the magnetron exciter with an ultra-stable C-band signal generator and two traveling-wave-tube amplifiers, augmenting the radar receiver with a Doppler tracking loop and augmenting the digital equipment to provide the required radial-rate data extraction.

With the exception of the 3-Mw klystron, which is standard equipment on the newer and more advanced FPQ-6, the same basic modifications are made to the FPQ-6. The first FPQ-6 went into operation last week at the Antigua tracking station on the Atlantic Missile Range. At least six more of these sets are expected to become operational by mid-1963 on AMR sites at Cape Canaveral, Grand Bahama Island, San Salvador, Ascension Island, Pretoria (South Africa), and Bermuda. An eighth set will be situated at NASA's Wallops Island installation.

• **10% hardware increase** — The hardware required to add the velocity measurement capability, RCA claims, represents only about a 10% increase over the basic radar equipment volume. The cost, they report, depending upon quantity to be modified, should not ex-

eed a maximum of 25% of the cost f the basic radar. Cost of a single FPS-6 is about $1 million. The FPQ-6 runs o roughly $3 million.

To provide long-distance track, a C-band coherent pulse beacon has also been developed and breadboarded at Moorestown. Project engineers report a 450-watt solid-state version of the beacon installed in a missile or spacecraft would permit tracking of the vehicle to about 10,000 mi. with the FPS-16 and to about 10 times that distance with the FPQ-6. Normally, skin track on a 1-sq.-meter target for the FPS-16 is 200 mi., with the FPQ-6 ranging to about 600 mi. The FPS-16 can be equipped with either a 12- or 16-ft. dish, while the FPQ-6 uses a 29-ft. cassegrain reflector.

The beacon developed for this system reportedly will receive the transmitted radar pulse, amplify it, and retransmit without materially affecting the RF phase and frequency content of the pulse.

The technique used here differs from conventional pulsed beacons where received pulses generally trigger a magnetron or triode output device producing a return pulse having no precise phase or frequency relationship to the incoming signal. RCA engineers say that problems associated with preservation of pulse coherency in the radar beacon have been largely resolved during fabrication of the working breadboard.

Engineers at the firm state that the basic techniques used in the new instrumentation system are essentially the same as those employed in the RCA-built TRADEX (Target Resolution and Discrimination Experiments) radar which reportedly has been operating effectively during its first month in use at the Kwajalein site in the Pacific.

• **Future in doubt**—Though RCA officials are enthusiastic about the system, and response from visiting DOD and NASA technical representatives attending demonstrations at the New Jersey facility last week was said to be "very favorable," the actual future system deployment remains cloudy.

For some applications, RCA officials say, the system may have to buck already heavily funded advanced instrumentation programs such as AMR's short base line MISTRAM system (M/R, Nov. 26, p. 112) and the long base line nets such as the AF's GLOTRAC (M/R, Nov. 26, p. 42) and NASA's new Range & Range-Rate system (M/R, March 12, p. 22). Company officials emphasize they "are not trying to displace anything that NASA and the AF have done," and, in some cases (particularly NASA's RRR net) they feel "the RCA device can serve to supplement these others for certain programs."

Nonetheless, company spokesmen say they will propose their modification program for both global tracking and individual missile range use "as a rapid, flexible, and inexpensive means to achieve position and coherent velocity data with accuracies equivalent to any other system."

RCA expects interest to be high at all ranges with a heavy investment in FPS-16 and FPQ-6 equipment (AMR, PMR, White Sands, Eglin, and the *Mercury* tracking net). It is placing particular emphasis on downrange use at AMR, or any similar testing area where shipboard equipment may be necessary. It contends that short-base line systems face limitations due to unavailability of stable and well surveyed island sites and are inherently prohibited from shipboard operation.

Two FPS-16-equipped tracking ships are said to be available downrange at AMR, one at PMR, with another one on order for the Pacific range.

The development of the RCA system was made under contract from the Army's Signal and Research Development Lab at Ft. Monmouth. Cost of the program to date is about $170,000. Tests of system performance thus far have been made using internally generated systems, fixed targets, aircraft targets, balloon-borne metal spheres, and beacon-equipped trucks and conventional aircraft. ⌗



Titan II's Test Cell Goes Up

VERTICAL TEST cell now being built at Martin Co.'s Space Systems Div. near Baltimore will be used to check out and test Titan II launch vehicle systems. Seventy feet will be added to existing structure to make room for 103-ft. vehicle.

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In test with troops . . .

Davy Crockett Reported Successful

Official announcement refers to 'low-yield nuclear system' test; radiation negligible

by James Trainor

A TEST of *Davy Crockett*—one of the Army's most mobile tactical atomic delivery systems—was carried out successfully under simulated battlefield conditions at the Atomic Energy Commission's Nevada Test Site on July 17, according to reliable sources.

An atomic weapon designed specifically for close support of combat troops, *Davy Crockett* is a jeep-mounted, 279 mm supercaliber projectile with a fractional nuclear yield.

The Nevada test, although not specifically designated as a test of the tactical weapons system, included some 900 troops from the Fourth Infantry Division at Fort Lewis, Wash., conventional artillery firing with weapons of a maximum 105mm caliber, and the firing of a ground nuclear system.

Official reference to a low-yield, nuclear system test, rather than a nuclear test device, indicated it was the *Davy Crockett* which was tested.

The tactical exercise—known as "Ivy Flats"—was the first involving troop maneuvers since July 5, 1957, when some 2000 Marines participated in "Operation Hood." Although neither DOD nor the AEC would confirm it, reports from the area indicated that tanks as well as troops participated in the latest exercise.

Exploded during the maneuvers, according to the AEC announcement, the tactical nuclear device produced a fireball of undisclosed size and a cloud which rose to about 10,000 ft. before breaking up. Radiation from the test was negligible, the announcement said.

• **System description**—*Davy Crockett* is capable of firing atomic or conventional warheads and is designed for use by infantry and armor units. An in-house project of the Army Weapons Command at Rock Island Arsenal, the system is produced in two versions—a light model (150 mm) weighing about 150 lbs. and a heavy model (155 mm) weighing about 375 lbs.

Both are recoilless rifles with launching pistons to adapt the bulbous projectile to the smaller caliber bore. With their ground mounts both systems can be disassembled and carried by the weapon crews, as well as mounted on a ¼-ton truck.

The range of the larger weapon is 4000 meters (4373.3 yds.) while the smaller has a range of 2000 meters (2280 yds.). Both fire warheads of less than 1 KT.

• **Deployment** — During the past six months, units of the U.S. Seventh Army in Germany have reportedly been equipped with the *Davy Crockett*. The nuclear warheads, however, have been maintained in Ordnance Depots to insure control over their employment.

Other units in Germany as well as high-priority STRAC units within the U.S. are next in line to get the *Davy Crockett*. Then, presumably, U.S. units in Korea would be equipped with the atomic delivery system.

The speed with which Army units will be equipped with *Davy Crockett* appears to be a matter of some disagreement between DOD and the Army. Secretary of Defense McNamara has said that the Army will reach its inventory objective in FY '63; the Army says under the present pace of modernization it will be FY '65 before units are equipped—and FY '67 before the inventory objective is reached. During FY '63, $12.5 million is programed for the system.

The basic fire unit, according to the Army, is the weapons squad or weapons section within the weapons company of the battle group. The weapon will primarily be used in combat against such targets as pillboxes, artillery positions, bunkers, troop and armor concentrations, command posts and supply dumps. Its effective blast radius is reported to be from 200 to 500 yards.

In fact, the Army claims that the nuclear-tipped *Davy Crockett* is designed to "dwarf in firepower anything we have ever known in the immediate battle line." ⌗



DAVY CROCKETT is jeep-mounted, designed for use by infantry or armored troops.

The Industry Week

Industry Trends and Forecasts

Over-emphasis on standardization may be impeding progress in electronic packaging design, Douglas Aircraft's George Litman, mechanical design supervisor, told the Aerospace Electrical Society in Los Angeles. Standardization, he said, too often is presented as a remedy for all design problems involved in electronic packaging. The fallacy in over-standardization lies in the fact that while cost and schedule are important, size, weight and environment have more effect on design . . . *Martin Co.'s Electronic Systems & Products Div. developed new manufacturing technique for making digital control modules for space applications that reduced unit cost 25%, increased production 41%, and increased reliability to near-100%* . . . Technical Training Consultants, Inc., Washington, D. C., is offering an intensive, five-day course in "pricing and negotiating prime and sub-contracts in the defense and aerospace industries." It will be given Aug. 27 through 31 at the Hilton Inn, San Francisco and Dec. 10 through 14 at the Marriott Motor Hotel, Dallas. . . . *The Garrett Corp's AiResearch Manufacturing Co., Phoenix, rejected union representation when employees voted 1243 to 349 against joining the International Union of Electrical, Radio and Machine Workers in a National Labor Relations Board election.*

Corporate Division Changes

Allen Manufacturing Co., Hartford, Conn., formed a division to specialize in threaded fasteners and related metal parts for the aerospace industry. . . . *Davies-Shea, Inc., Chicago electronics/aerospace personnel consultants, formed an Execu-Search Division to locate and screen executives for positions paying $20,000 and over in the aerospace industry.* . . . American Machine and Foundry's Leland Airborne Products Div. formed a group to develop and market specialized test equipment. Initial offerings will be power-type instrumentation for checking inverters, regulators, power supplies and similar devices.

New Industry Facilities

Beckman Instruments, Inc.. is building a $1,250,000 engineering wing at its Fullerton, Calif., headquarters plant. The unit will provide space for expansion and centralization of related engineering functions. . . . *Robertshaw-Fulton Controls Co. will shift corporate headquarters from downtown Richmond, Va., to the company's new suburban building.* . . . Climax Molybdenum Co. Refractory Metal Div. moved its marketing section from New York to division headquarters in Detroit. . . . *The Martin Co. is building a vertical test facility for Titan II at its Middle River, Md., plant. The $401,000 facility will be used to checkout and test Titan II-Gemini launch vehicle systems.* . . . Cannon Electric Co. opened a sales engineering office in Dayton, Ohio, and new sales offices in Cleveland and Detroit. . . . *Maxon Electronics Corp. is building an engineering and research center at Great River, Long Island.* . . . American Electronic Laboratories, Inc., is building an addition to its recently-completed research and production facility. . . . *Aerospace Corp. is establishing a White Sands Flight Test Office at Holloman AFB to provide technical support of portions of the AF special test-vehicle program.* . . . System Development Corp. opened an office in Dayton, Ohio. Personnel will include operations research scientists, human factors scientists, and computer systems specialists. SDC specializes in design and development of command, control and management systems for military, governmental, scientific and educational applications . . . *United Aircraft Research Labs began work on a new office and laboratory building in East Hartford, Conn., that will "be used to expand the basic and applied research programs being carried on by the company in most of the physical sciences important to space flight."*

News of Mergers and Acquisitions

SKF Industries, Inc., acquired Bremen Bearings, Inc., Bremen, Ind., manufacturers of needle bearings, loose needle rollers and pins. . . . *California Airmotive Corp., North Hollywood, Calif., acquired Aircraft Engines and Metals Corp., Long Beach, Calif.* . . . Accoustic Chemical Corp. has been merged into Intrado Corp. through exchange of stock and assumption of company obligations. . . . *Singer Manufacturing Co. reached a tentative agreement to purchase Panoramic Electronics, Inc., Yonkers, N. Y., in a move to expand Singer activities into the electronics field.* . . . General Kinetics Inc., Arlington, Va., acquired Computer Instrumentation Corp., Philadelphia. GKI designs and manufactures specialized production and preventive maintenance equipment for magnetic tapes. . . . *Monogram Precision Industries, Inc. acquired 80% of J.S.L. Corp., Vega Alta, Puerto Rico, designers and manufacturers of small hand tools and automated machined components used in the aerospace, electronics and metals industries.*

New Names in The Industry

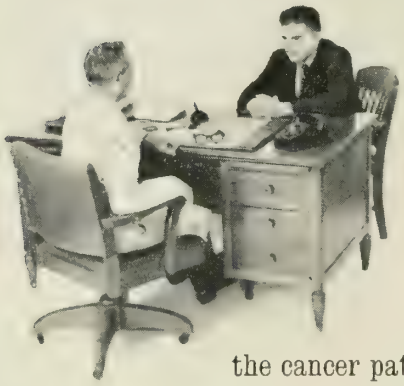
Wilk Instrument was formed in Los Angeles as a division of Quality Electric Co. to manufacture and market precision measuring instruments in the fields of calibration standards, quality control, and electronic research. A new product line of instruments to be offered by Wilk includes an A.C. Calibrator, Lindeck Potentiometer, A.C. Transfer Standards, D.C. Incremental Voltmeter and A.C./D.C. Precision Voltmeter.

International News Briefs

Henschel-Werke Aktiengesellschaft, Kassel, West Germany, established a subsidiary in Belgium, N.V. Henschel-Belge S.A., near Antwerp. The company manufactures gears for machine manufacture as well as other purposes.

SWORD WITH A POINT®

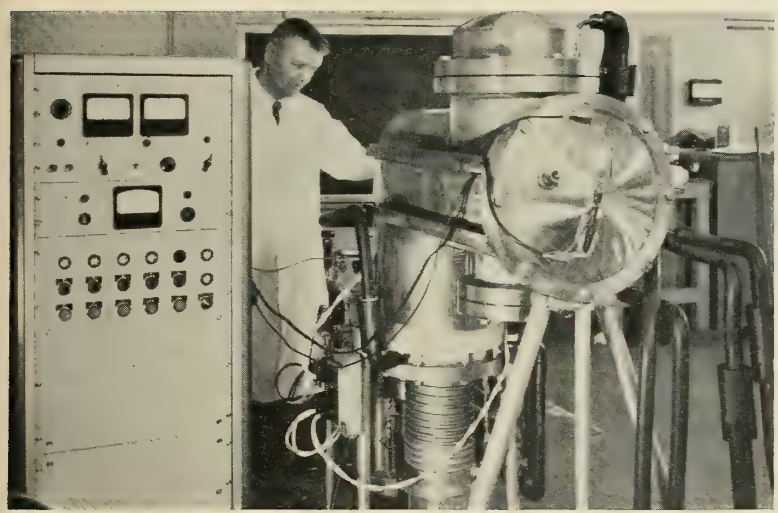
The sword of hope of the American Cancer Society offers ✦ **HOPE** for the cancer patient today: One in three is being saved, compared with one in seven only twenty-five years ago. The American Cancer Society's public education messages are alerting more and more people daily to the vital importance of regular health checkups, to the urgency of early diagnosis and proper treatment, and to a host of other life-saving facts about cancer.



✦ **HOPE** for the family of the cancer patient: They can turn to the Society's service activities for assistance in relieving physical and psychological problems. ✦ **HOPE** for tomorrow's cancer patient: He will benefit from his physician's knowledge of latest advances in the diagnosis and treatment of cancer—knowledge largely provided through the American Cancer Society's professional education program. And, through the Society's vast research program, important new discoveries are being made which can ultimately mean an end to cancer. ✦ This is the program of the American Cancer Society. Its sword of hope points the way to a future free of cancer. AMERICAN CANCER SOCIETY®







New Product of the Week: Building-Block Space Simulator

ILIKON CORP.'S MODEL 103 space simulator doubles as the basic building block for anticipated larger space simulation chambers of any volume up to 30 cu. ft.

In its basic form, the all-metal Model 103 features a compact chamber of 2 cu. ft., making it an ideal miniature ultrahigh vacuum or space simulation system for such laboratory and production line applications as space testing of small components, ultrahigh vacuum experimentation, thin-film disposition and solid-state research.

Where a larger chamber is called for, the modular design of the Model 103 permits it to be used as a high-efficiency pumping system of that larger system. This is accomplished by bolting the Model 103 to the larger size Ilikon-designed metal chamber, creating a new system of any volume up to 30 cu. ft. with the same ultrahigh vacuum capabilities as the Model 103.

The company guarantees the system to be capable of producing a pressure of less than 2 x 10^{-10} mm Hg.

Circle No. 225 on Subscriber Service Card

A-C Converters

A series of four fast, low-cost, all-silicon, solid-state analog-to-digital converters are available from Scientific Data Systems, Inc. Operable at speeds in excess of 5 microseconds per bit, the units have accuracies to ±0.01% and will withstand operating temperatures from 0°C to 100°C. Input ranges are available from ±1V to ±100V with input impedances from 250 ohms/volt to 10,000 ohms/volt.

Circle No. 226 on Subscriber Service Card

Core Memory Testing Instrument

A high-speed core memory-testing instrument that combines and integrates equipment and circuitry is available from International Computer, Inc.

Model 701 has 5 current drivers, 3 negative for X and Y read and inhibit and 2 positive for X and Y write current. Each driver has the following control: pulse delay of 1 to 2 us, pulse width of 0.5 to 5.0 us, pulse rise and fall time of 0.15 to 0.5 us (with 0.15 us at 300 ma and 0.2 us at 600 ma). With a pulse amplitude of 600 ma, driver saturation is 18V. Higher or lower voltage kick-back is available with option drivers or lower pulse repetition rate.

Circle No. 227 on Subscriber Service Card

Frequency Multiplier

A phase-coherent multiplier, Model 90948, is available from Resdel Engineering Corp. The unit will multiply an input frequency of 100 mc by 5, 10 and 100 providing separate outputs with 25 mw minimum at 500, 1000, and 5000 mc and 10 mw minimum at 10,000 mc with a coherent phase relationship to the input signal.

The 90948 has a phase jitter of less than ±15%. The unit has frequency multipliers capable of being tuned throughout the entire range.

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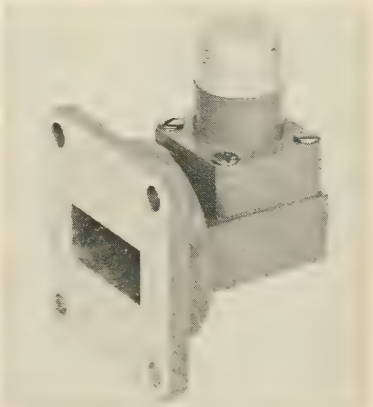
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thereby acting as a probe. The coaxial section is provided with a standard type N connector and the waveguide section contains a standard waveguide cover flange.

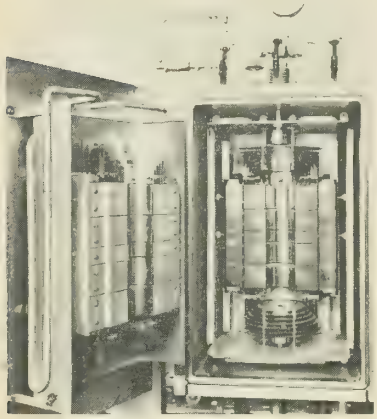
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Tensile Test Furnace

A tensile testing furnace developed by High Vacuum Equipment Corp., subsidiary of Robinson Technical Products, can be used with most standard tensile and creep test machines and permits tensile or compression testing under controlled-atmosphere or high-vacuum conditions. Other features of the type 38 testing furnace include zoned heating element designed to meter power for maximum temperature uniformity, and bellows-sealed feed-throughs. The heated zone is 3 x 8 in. ID, with a temperature capability to 2600°C.

The unit is designed for rapid cycling to 5 x 10^{-6} torr vacuum or better, interchangeability of tungsten or molybdenum elements and shields, and attachment of temperature-indicating and recording instruments.

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Angular Motion Compensator

Compen-Theta Model AAC-300, a miniature precision angular-motion compensator, is being marketed by American Aerospace Controls, Inc., a subsidiary of Univis, Inc.

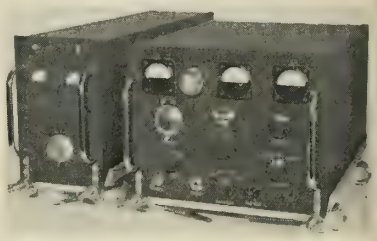
The input and output shafts on Model AAC-300 extend from opposite ends of the cylindrical housing. The compensator mechanism accepts an angular rotational input to the input shaft and differentially advances or retards the output shaft as a function of eighteen adjustment cams. The device is normally connected through gearing to a rotating electrical component such as a synchro, potentiometer or rotary capacitor. The unit compensates for repeatable errors in the electrical component and is built to military specifications.

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Airborne VHF Telemetry Receiver

A two-unit airborne VHF telemetry receiver, tuning 215 to 265 mc is being marketed by General Electronic Laboratories, Inc. Meeting the latest IRIG specifications, the double-conversion superheterogyne receiver features switch-selected crystal-controlled or continuously tunable operating modes and receives FM/FM, PDM/FM, PCM/FM, PAM/FM and AM signals with a noise figure of less than 7 db.

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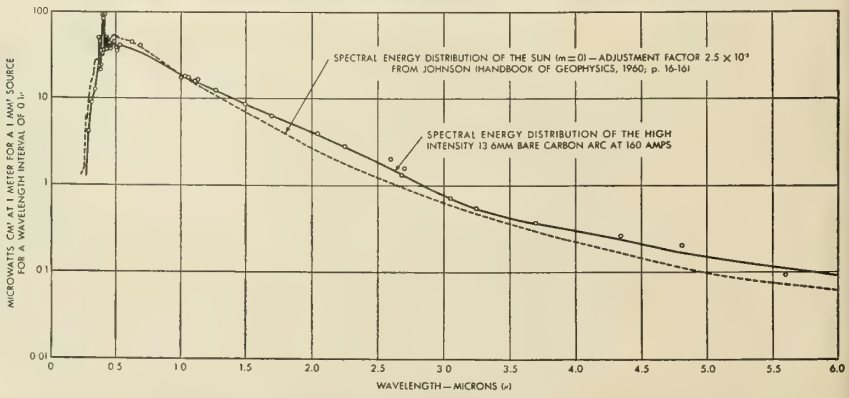
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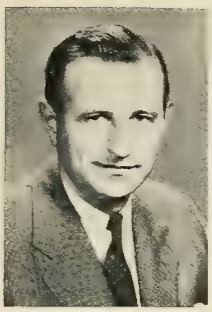
names in the news



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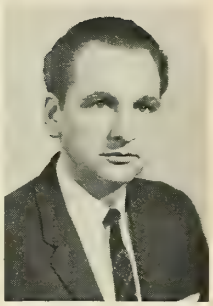
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THOMAS



HORWITZ



KAUFMANN

Andrew F. Haiduck: Appointed president of the Astronics Div. of Lear Siegler, Inc., Santa Monica, Calif.

Melvin A. Raney: Elected president and chief executive officer of The Lionel Corp., New York City.

Bernard N. Riskin: Joined the staff of National Computer Analysis, Inc., Princeton, N. J., as project engineer.

Richard U. Surbeck: Named director, international marketing, for the Defense Products Div. of Fairchild Camera and Instrument Corp., Syosset, N. Y.

Sol Schwartz: Appointed president of Designatronics, Inc., Mineola, L. I., N. Y.

Stephen A. Keller: Elected president of Telex, Inc., Minneapolis.

Robert P. Egermeier: Appointed to organize and manage Aerospace Corp.'s White Sands (N. M.) Flight Test Office.

Carter Burgess: President of American Machine & Foundry Co., New York City, awarded the AF Ballistic Systems Division's Commander's Award.

Dr. Meredith C. Gourdine: Named chief scientist of the Wright Aeronautical Div., Curtiss-Wright Corp., Wood-Ridge, N. J.

Joseph P. Tumminaro: Appointed vice president of manufacturing of Standard Kollsman Industries, Inc., Melrose Park, Ill.

James F. Towler: Promoted to chief engineer for Regency Electronics, Inc., Indianapolis, Ind.

George F. Vila: President of U. S. Rubber Co., elected a director of ACF Industries, Inc., New York City.

Dr. Robert G. Ulrech: Elected vice president, engineering, Consolidated Vacuum Corp., Rochester, N. Y. **Robert O. Johnson** elected vice president, field sales.

Philip C. Garratt: Vice president and managing director of de Havilland Aircraft of Canada Ltd., named an Honorary Fellow in the Canadian Aeronautics and Space Institute.

Dr. Philip J. Wyatt: Appointed director of advanced planning of the Engineering Sciences Div., Plasmadyne Corp., Santa Ana, Calif.

Joseph M. Stern: Appointed product manager of MicroSemiconductor Corp., Culver City, Calif.

Barry R. Norman: Appointed reliability manager for Wyle Laboratories' West Coast Testing Div., El Segundo, Calif.

Robert M. Thomas, Jr.: Appointed senior vice president and general manager of the Thomas & Betts Co., Elizabeth, N. J.

Dr. Gordon MacBeth: Appointed manager of production technical service, Memorex Corp., Santa Clara, Calif.

Dr. James F. Sutton: Named director of research for Lockheed-Georgia Co., Atlanta.

Wenzel M. (Doc) Wochos: Appointed general manager of Cannon Electric Co.'s Pheonix Div.

Robert T. Vance: Appointed administrator of the newly formed Contracts Dept., Microlab, Livingston, N. J.

Carl B. Burnett: Appointed LARC program manager, Consolidated Diesel Electric Corp., Stamford, Conn.

Austin B. Speed: Named director of sales for the subcontracts and services department of Republic Aviation Corp., Farmingdale, L. I., N. Y.

Tracy W. McFarlan: Named product manager of ultrasonic testing equipment for Magnaflux Corp., Chicago.

Arthur F. Dickerson: Named manager of advanced engineering for the Advanced Planning Operation of General Electric's Electronic Components Div., Schenectady, N. Y.

Robert J. Lawrence: Appointed senior principal engineer of Adler Electronics, Inc.'s Government Products Div., New Rochelle, N. Y. **John T. Kobi** appointed principal engineer.

C. A. Papp: Appointed director of the plasma chemistry laboratory of Plasmadyne Corp., Santa Ana, Calif.

William C. Comer: Appointed vice president-sales, DIT-MCO, Inc., Kansas City, Mo. **Fred N. Epperson** appointed vice president-manufacturing and **Price D. Wickersham** appointed vice president-engineering.

Louis B. Horwitz: Named technical director of Beckman Instruments, Inc., Fullerton, Calif.

Dr. Leslie S. Radnay: Appointed project engineer and consultant for high-frequency communications, Manson Laboratories, Inc., Stamford, Conn.

Dr. Norman E. Friedmann: Elected assistant vice president, California operations, of International Telephone and Telegraph Corp.'s Federal Laboratories, Nutley, N. J.

John C. Kaufmann: Appointed northeast industrial OEM manager for The Thomas & Betts Co., Elizabeth, N. J.

B. R. Teree: Appointed director of engineering for Adel Corp., Burbank, Calif.

Joseph J. Sedik: Appointed marketing manager for the Gabriel Electronics Div., Millis, Mass.

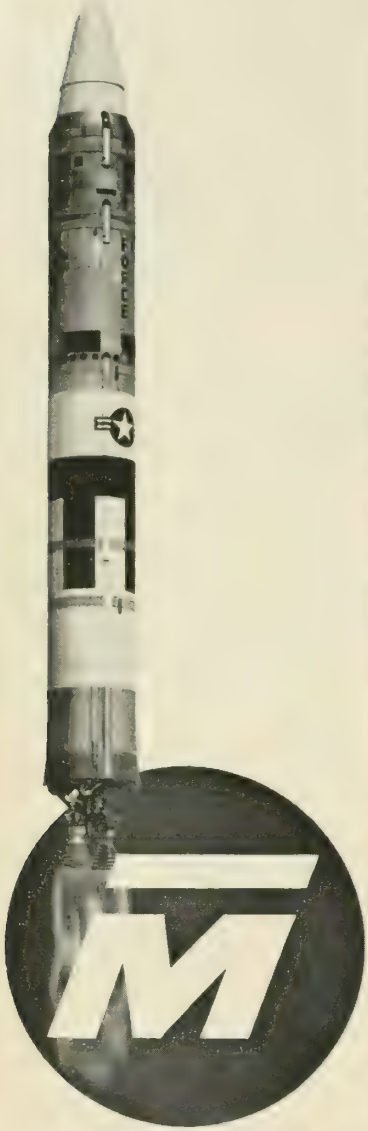
Peter H. Bliss: Named manager of product planning at the General Electric Communication Products Dept., Lynchburg, Va.

Ian B. Dickson: Named director of manufacturing for American Micro Devices, Inc., Phoenix, Ariz.

Christopher T. Kastner: Appointed general manager of Baldwin-Lima-Hamilton Corp.'s industrial sales division.

Robert A. Marshall: Director of marketing for the Federal Electric Corp., Paramus, N. J., elected a vice president of the corporation.

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soviet affairs

by Dr. Albert Parry

'Chrysanthemums and Rockets' is the title

of an angry attack in *Krasnaya Zvezda* of July 6 on the decision "of the national defense authority in Japan to create, for the first time in that nation, units armed with rocket weapons." The daily newspaper of the Soviet military forces, in the article signed by Colonel P. Krainov and Captain (naval) V. Pustov, chides the Japanese government for its "close collaboration with the Pentagon" in this "speed-up of Japan's rearmament" through missilery. The charge reads: "Warhead-rocket manufacture is already being organized at Japanese plants. In addition, rocket arms are being purchased abroad, partly in the USA."

Some rocket collaboration would be excusable

if only Japan would do such business with the Soviet Union instead of the United States. This hint is clear from an article by Nicholas Kotysh, *Krasnaya Zvezda's* special correspondent who accompanied Major Yuri Gagarin on his recent trip to Japan. Writing in the military newspaper on June 7, Kotysh described his and Gagarin's visit with a group of Japanese interested in rocketry. A Tokyo expert in radio-electronics, after a few words with Gagarin on the use of electronics in the *Vostok* spaceships, suggested to the Russians: "Place orders with us." The Russians responded: "All right, we will place orders with you. But will you fill them?" The Japanese were described as first hesitating with their answer, then admitting that Americans would not permit such a Soviet-Japanese rocket deal. The Japanese were quoted as saying, "We are ready, but . . ." The "but" was interpreted by the Russians as Japanese fear of American displeasure. Incidentally, among the problems on which the Japanese told the Russians they (the Japanese) were working was the use of titanium and aluminum in building a heat-resistant rocket frame.

To answer several inquiries,

general and specific, which reached me in the wake of my recent column on Soviet "land-rockets" (MISSILES AND ROCKETS, July 9), let me say this: While Khrushchev in his speech of May 10 stated that only four or five experimental models of the rocket-drill existed by then, the actual number as reported by the Soviet industry appears to be even smaller. The very first model was constructed four years ago and still seems to be in occasional use. The State Plan called for the Buzuluk plant to build 9 rocket-drills in 1960 and 10 in 1961, but only one rocket-drill was produced in those two years. The program for 1962 demands 10 more, but by mid-May none was built. (*Pravda,* May 21). The Krivoi Rog iron ore mines in the Ukraine are now using a rocket-drill, and a new model was tested last spring by the Scientific Research Institute of Drill Technology. (*Trud,* May 9.) The newsreel containing a brief view of the rocket-drill, which was spotted by Khrushchev and led to his revival of Soviet interest in the invention, is not available in this country. However, a lengthier documentary film on the rocket-drill, "The Fiery Spear," has recently been completed for immediate release to the USSR's motion picture houses. (*Komsomolskaya Pravda,* April 14.) Its eventual export to foreign film theaters is possible.

Sloppy writing on rocketry

is denounced by Academician G. Petrov in *Pravda* for May 23. Among other examples of Russian pseudo-science, he castigates the book entitled *Theoretical Foundations of Blueprinting Liquid-Propelled Rocket Engines,* a doctoral dissertation by M. I. Shevlyukov printed by the State Defense Publishing House in 1960. The critic points out the total uselessness and even harmfulness of the book due to its gross mistakes that "should be evident even to high-school graduates" and would be "unforgivable even if made by students." Listing a number of such errors, the academician wonders how this so-called work could pass as a doctoral thesis at the Leningrad institute, where it won its author his coveted degree; how it could be accepted for publication; and, worst of all, how it could have been recommended by the USSR's Ministry of Higher Education as a textbook for technical colleges.

contracts

AIR FORCE

$14,414,600—**General Dynamics Corp.,** San Diego, for *Atlas* ground support equipment (3 supplemental contracts).

$9,468,000 — **Boeing Co.,** Seattle, for follow-up work on *Minuteman* missile research and development (supplemental contract).

$6,200,000 — **North American Aviation Corp.,** Downey, Calif., for research and development on *Minuteman* guidance and control systems (supplemental contract).

$4,210,000—**Aerojet-General Corp.,** Sacramento, for research and development and other work during Phase I of improvement of Stage II *Minuteman* motors (supplemental contract).

$3,900,892—**Radio Corp. of America,** Burlington, Mass., for provision of final stage vehicles and services in support of satellite programs.

$3,000,000—**North American Aviation, Inc.,** Downey, Calif., for production of *Minuteman* guidance and control systems (supplemental contract).

$3,000,000—**Lockheed Aircraft Corp.,** Sunnyvale, Calif., for research and development for a space program (supplemental contract).

$3,000.000—**Lockheed Aircraft Corp.,** Burbank, Calif., for aerospace research.

$2,500,000—**Ling-Temco-Vought, Inc.,** Dallas, for additional aerothermodynamic data and design information relating to development of a nuclear ramjet propulsion system.

$2,000,000—**General Dynamics Corp.,** San Diego, for operation and test of a systems test facility at Vandenberg AFB.

$1,800,000—**Continental Aviation and Engineering Corp.,** Detroit, for work on a classified project.

$1,600,000—**Kollsman Instrument Co.,** New York City, for celestial navigation systems spare parts and test equipment.

$1,118,000—**General Dynamics Corp.,** San Diego, for work on technical publications for *Atlas* missiles (supplemental contract).

$730,000—**Kollsman Instrument Co.,** New York City, for spare parts for Kollsman KS-120 and KS-140 astro tracking subsystems.

$679,000—**Electronic Associates, Inc.,** Long Branch, N. J., for simulating various aspects of the *X-20 (Dyna-Soar)* space program at Edwards AFB, Calif.

$99,289—**Martin Co.'s Research Institute for Advanced Study,** Baltimore, for research in nonlinear mathematics relating to problems in space flight, long-range communications and automation.

$71,000—**Melpar, Inc.,** Falls Church, Va., for seismic research aimed at advancing the nation's underground explosion detection program as part of Project *Vela-Uniform.*

Kollsman Instrument Co., Elmhurst, New York City, for exploration of the feasibility of manual space-position fixing aboard orbital and space vehicles (undisclosed amount).

ARMY

$21,202,343—**General Dynamics Corp.,** Pomona, Calif., for continued research and development of the *Mauler* weapon system.

$3,426,480—**Northrop Corp.,** Ventura, Calif., for extension of the contractor-operated flight service program on the *RP-76* rocket-powered target.

NAVY

$3,200,000—**Goodyear Aircraft Corp.,** Akron, Ohio, for continued research and development on *Subroc* missile system.

$1,300,000—**Ryan Aeronautical Co.,** San Diego, for airframe spare parts for Navy *Q-2C Firebee* jet target drones.

$1,247,236—**Land-Air, Inc.,** Chicago, for mathematical and related engineering services at the Pacific Missile Range.

NASA

$4,000,000—**Beech Aircraft Corp.,** Wichita, Kan., for building the super-critical gas storage systems for the *Apollo* spacecraft.

$1,300,000—**Union Carbide Corp.,** New York City, for liquid-hydrogen handling facilities at Cape Canaveral for *Saturn* Complex 34 launch pads.

$505,637—**Avco Corp.,** Wilmington, Mass., for development work on a 30-kilowatt arc jet rocket engine.

$390,000—**California Computer Products, Inc.,** Downey, Calif., for design, development and fabrication of three advanced ground stations and three satellite command clock systems.

$390,000—**California Computer Products, Inc.,** Downey, Calif., for work in the *Nimbus* weather observation satellite program.

Aero Geo Astro Corp., Alexandria, Va., for design and fabrication of instrumentation and components which will be used on space satellites and scientific analyses of problems connected with satellite payloads (undisclosed amount).

Telecomputing Services, Inc., Los Angeles, for data-reduction services on *Saturn* program (undisclosed amount).

DOD

$607,000—**Ford Motor Co., Aeronutronic Div.,** Newport Beach, Calif., for study of improved ways to penetrate enemy defense systems with ballistic missiles.

INDUSTRY

$300,000—**Beckman Instruments, Inc.,** Richmond, Calif., from **Pratt & Whitney Aircraft,** for an analog computer system which will help solve design problems on rocket engines.

$112,103—**Electro-Optical Systems, Inc.,** Pasadena, Calif., from the **California Institute of Technology,** for building prototype flight model fuel cells for spacecraft power systems. Work to be done at the Institute's Jet Propulsion Laboratory.

American Brake Shoe Co.'s Kellogg Div., Oxnard, Calif., from **North American Aviation Co.'s Space and Information Systems Div.,** for building components for the *Saturn* S-II stage (undisclosed amount).

NRC Equipment Corp., Newton, Mass., from **Compudyne Corp., C. W. Regan, Inc.** and **Acme Missile and Construction Corp.,** for diffusion pumps to be used in *Samos, Midas* and *Advent* space chambers.

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JULY

Mathematical Aspects of Celestial Mechanics, sponsored by AFOSR, SRMA, Yale University, New Haven, Conn., July 23-Aug. 3.

Business Intelligence and Advance Planning Seminar, sponsored by Operations Research, Inc., San Francisco, July 23-25.

PERT (Program Evaluation and Review Techniques) and CPM (Critical Path Method) Seminars, ITT Data Processing Center, Paramus, N. J., July 30-Aug. 1.

AUGUST

Engineering Foundation's Engineering Research Conference on Composite Materials, Tilton School, Tilton, N. H., Aug. 1-3.

International Conference and Exhibit on Aerospace Support, Washington, D. C., Aug. 4-9.

Society of Photographic Instrumentation Engineers, Seventh Annual Symposium, Statler Hilton Hotel, New York City, Aug. 6-10.

Low-Level Wind Conference, sponsored by American Meteorlogical Society and U. S. Army Signal Missile Support Agency, Texas Western College, El Paso, Aug. 7-9.

57th Meeting, National Aerospace Standards Committee, Aerospace Industries Assn., Benjamin Franklin Hotel, Seattle, Aug. 7-9.

1962 Standards Laboratory Conference, National Bureau of Standards' Boulder Laboratories, Boulder, Colo., Aug. 8-10.

Institute of the Aerospace Sciences, Man-Machine Competition, Olympic Hotel, Seattle, Aug. 10-11.

Pacific Energy Conversion Conference, American Institute of Electrical Engineers, Fairmont Hotel, San Francisco, Aug. 13-16.

Seventh Symposium on Ballistic Missile and Space Technology, U. S. Air Force Academy, Colorado Springs, Colo., sponsored by USAF and Aerospace Corp., Aug. 13-16.

Cryogenic Engineering Conference, University of California at Los Angeles, Aug. 14-16.

Nuclear Propulsion Conference, sponsored by ARC, AMS and IAS, U. S. Naval Post Graduate School, Monterey, Calif., Aug. 15-17. (All sessions are classified.)

Third International Electronic Circuit Packaging Symposium, University of Colorado, Boulder, Aug. 15-17.

American Society for Quality Control, Joint Western Regional Aircraft and Missiles Conference, Benjamin Franklin Hotel, Seattle, Aug. 16-18.

Western Electronics Show and Conference, Los Angeles Memorial Sports Arena, Los Angeles, Aug. 21-24.

International Symposium on Far Infrared Spectroscopy, Sheraton Gibson Hotel, Cincinnati, sponsored by Materials Central, Aeronautical Systems Div., Air Force Systems Command, Aug. 21-24.

AIBS-AAAS Meeting, Oregon State University, Corvallis, Ore., Aug. 26-31.

Third International Congress, International Council of the Aeronautical Sciences, New Congress Hall, Stockholm, Sweden, Aug. 27-Sept. 1.

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A Time for Action

IMMEDIATE Congressional action is needed to force a clarification of the management structure of the nation's nuclear space power program.

Despite some bland assurances that no disagreement exists, a study of the facts indicates an area of confusion over just where lines of authority are drawn in the *SNAP-50* and *SPUR* programs.

The text of a Memorandum of Understanding between the Atomic Energy Commission and the National Aeronautics and Space Administration is published on p. 13 of this issue. There is some disagreement even within the AEC on just what this document means.

Commissioner Robert Wilson told MISSILES AND ROCKETS several months ago "There is no agreement with anybody on how the tasks should be divided on large nuclear space power except *Rover.*"

Yet the AEC's general manager, Gen. A. R. Luedecke, told a Congressional committee in May, "The memorandum is slightly broader than that . . . I think the agreement is still a valid one."

It is plain from a reading of the memorandum that some grounds exist for both interpretations.

Yet the memorandum clearly assigns to NASA the "primary responsibility" for research and development on components and subsystems of nuclear systems other than the reactor, reactor components, and isotope power units. It also is agreed that NASA has primary responsibility for integration of the reactor into nuclear propulsion and *nuclear electric power generation systems.*

That in itself would seem to make the memorandum somewhat broader than just an agreement on *Rover*—and also would seem to place a limit on the AEC's role in the development of full systems.

Yet an official AEC statement to a House appropriations subcommittee declares: "The Commission conceives its role in the production of electrical power in space as one of design, development and test of a complete power package, including the power source and energy conversion system."

This AEC insistence on a broader role than outlined in the Memorandum of Understanding is at the root of a basic disagreement with both NASA and the Air Force concerning the lines of responsibility for system and component development.

MISSILES AND ROCKETS first brought this dispute into public view in an article by Engineering Editor William Beller last February. Following the appearance of that article, Rep. Melvin Price (D-Ill.) called top officials of the three agencies into an executive hearing in an effort to resolve the dispute. Questions based on the M/R article were asked in both House and Senate appropriation hearings.

Committee members were told either that there was no problem or that it was a minor one which was quickly being solved.

Deputy Secretary of Defense Roswell Gilpatric assured a Senate committee: "I believe whatever differences may have existed at certain stages and at certain levels in the agencies have been resolved. Certainly none have reached me and Mr. McNamara. I doubt if they are of a serious nature."

This seems a somewhat smug answer in view of the fact that top officials of those same agencies were testifying not only about a disagreement but were disagreeing over what the areas of disagreement were!

It also seems odd in light of a secret meeting held just two weeks after Mr. Gilpatric's testimony. Top officials including the NASA Administrator, an Under Secretary of Air Force and an AEC Commissioner met to discuss the presumably non-existent problem.

Out of that meeting came an agreement of sorts. Yet members of the three agencies already are arguing about what was decided.

Machinery exists for the settlement of such disputes. Mr. Gilpatric and Mr. Webb earlier this year exchanged letters of agreement under which DOD and NASA submit to each other their five-year plans. The purpose of this is to make certain that the two agencies not only avoid duplication or overlapping of effort but also make use of each other's technology.

Under such an agreement, the space-power needs of the two using agencies could be coordinated—just as the Large Launch Vehicle Planning Group introduced coordination in boosters. These requirements could be spelled out for AEC, which must supply at least the reactor and nuclear components. Then a new and clearer Memorandum of Understanding could be drawn up to carefully define the lines of research and development responsibility beyond that.

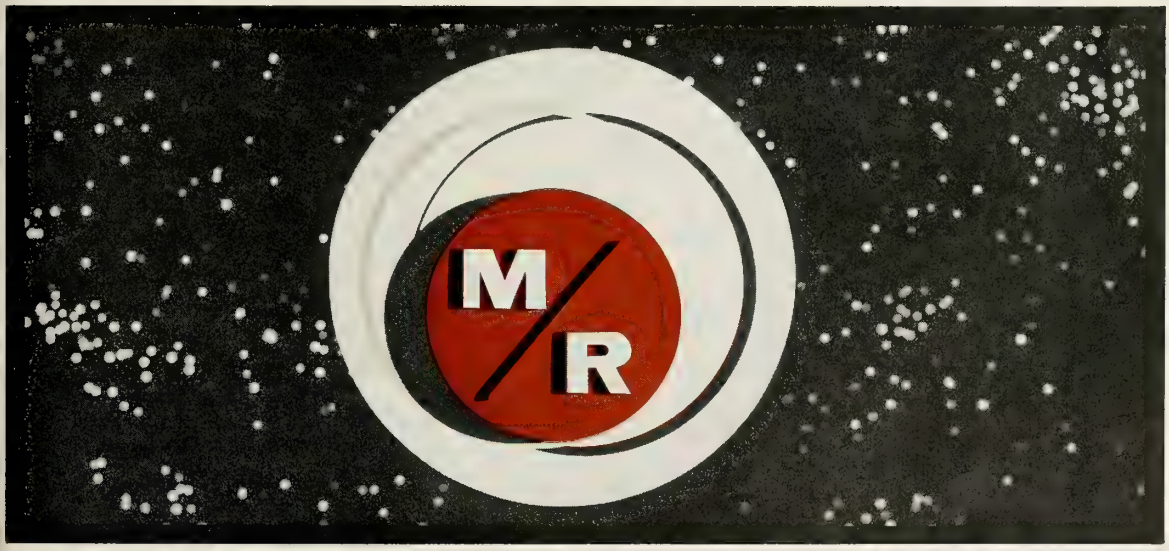
THE THREE AGENCIES thus far seem satisfied to let the situation remain as it is. Basis for this seems to be a belief that since the nuclear space power program is in a very early stage of research and development, some duplication or confusion is not particularly harmful.

True, this may not yet be a serious problem. But a Congressional committee recently criticized *Centaur* program management severely for the difficulties in that vital program. The time to solve potential troubles in the equally vital nuclear space power program is now—before the fact, not after.

William J. Coughlin



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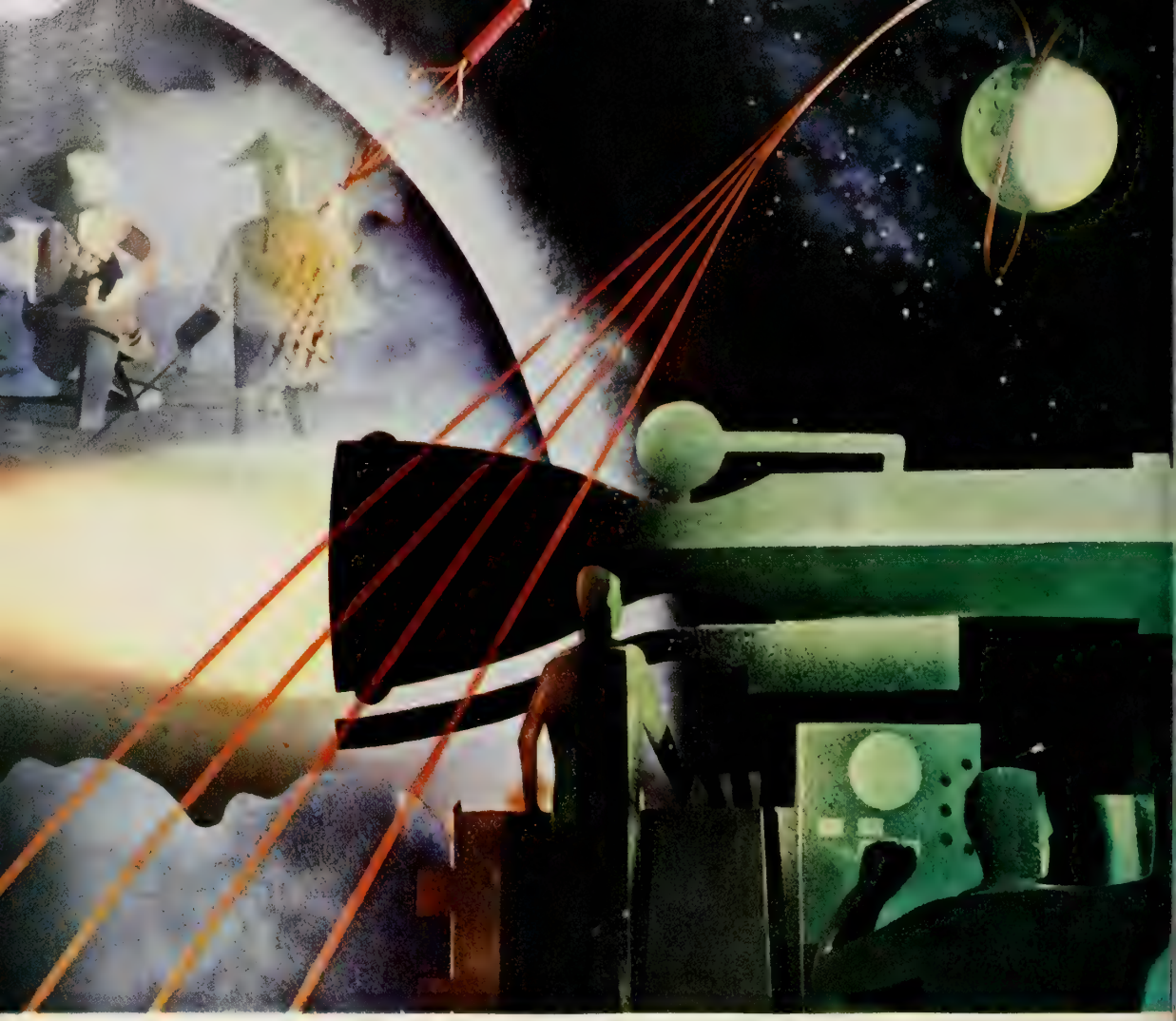
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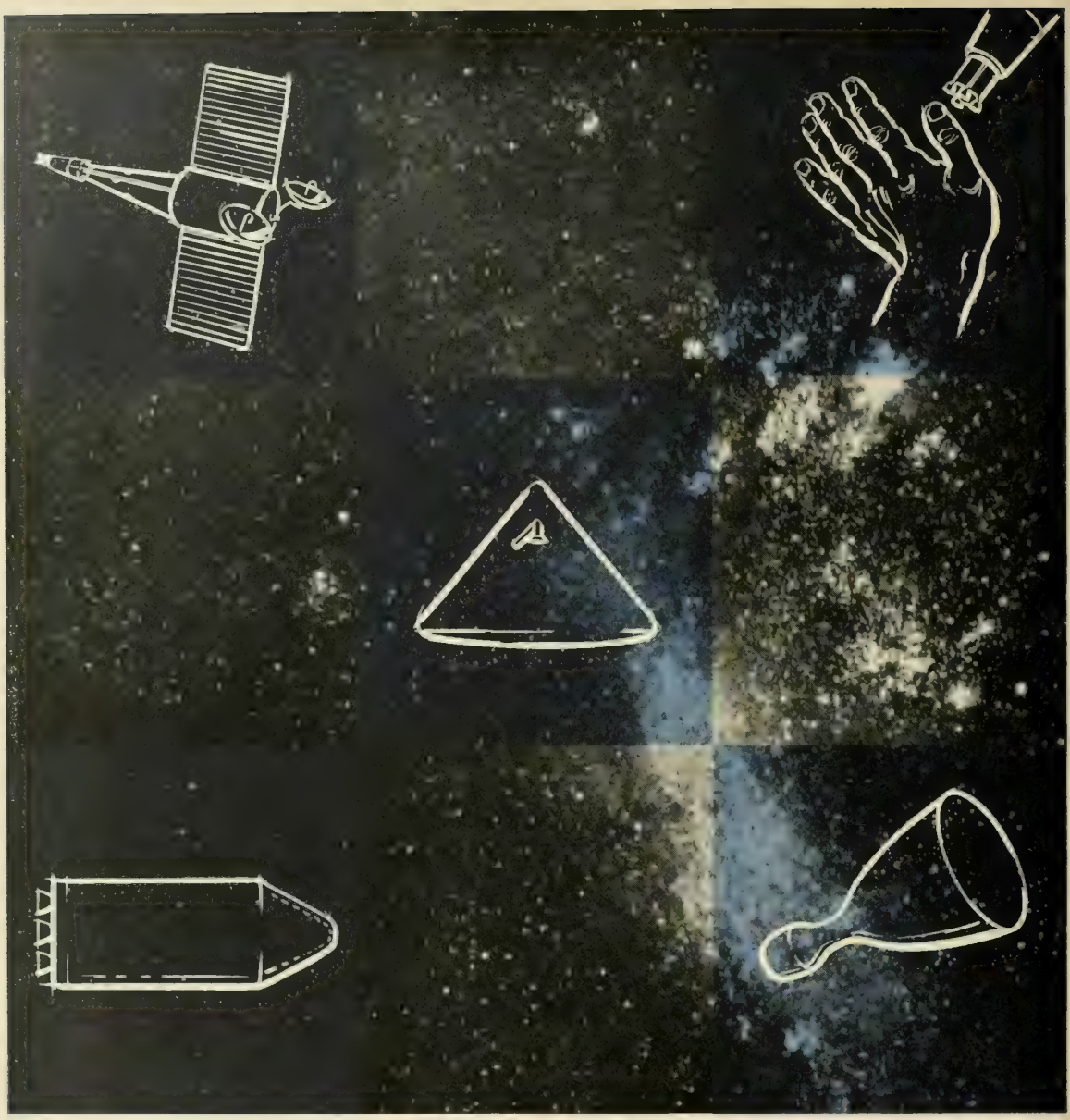
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Volume 11, Number 5 July 30, 1962

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THE COVER

Air Force Martin Titan I in silo at Lowry AFB, Colo., is representative of rapid progress in the U.S., missile/space effort reported in M/R's Sixth—and biggest—World Missile/Space Encyclopedia, which begins on p. 23 of this issue.



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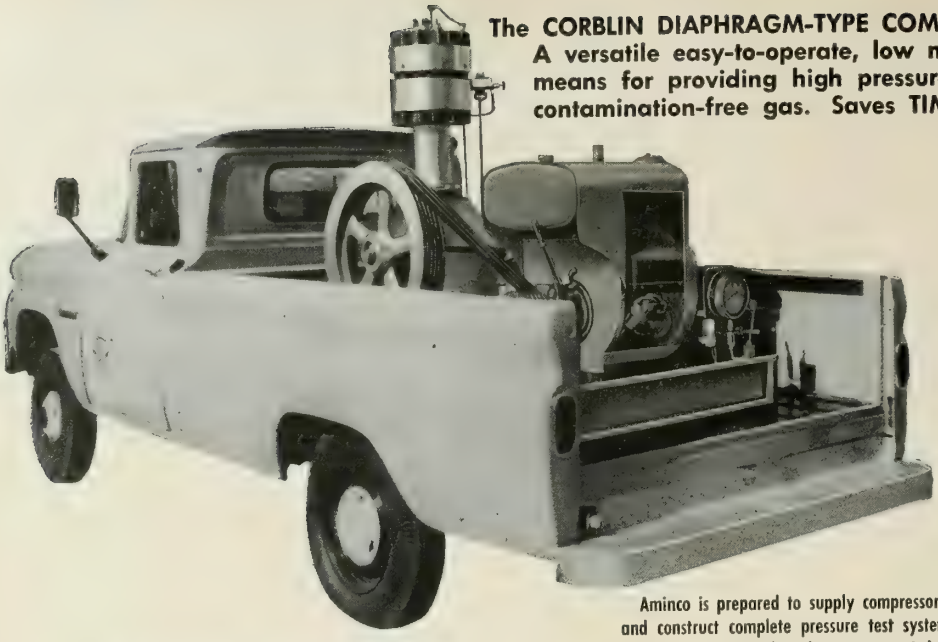
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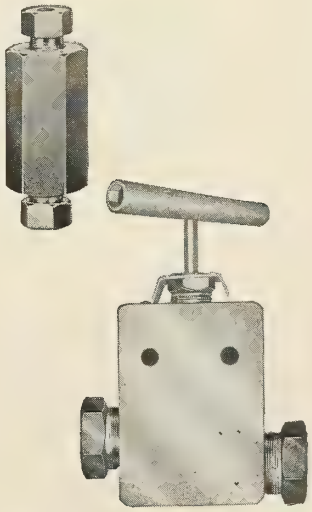
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Raps Titov, Lauds NASA

To the Editor:

Kindly let us, too, refer to your editorial ("Go Home, Russian," M/R, May 14, p. 46) and to the letter of our friend R. V. S. Mani (of Bombay) (Letters, M/R, July 2, p. 7) to underline from actual events the wide difference in the spirit of scientific research between the Free World and the Iron Curtain.

Not long ago, a group of scientists and technicians here founded the Scientific Rockets Research Group on Space for carrying out research and measurements on space. Having drawn up a special program, we recognized from the outset the need to concentrate scientific data and technical information on the subjects in our program.

With some hesitation, we turned first to NASA. To our great satisfaction, we at once received replies to all our questions, and complete scientific information and continual bibliographical reporting.

We must underline here not only the completeness of the scientific information furnished by NASA, but also the promptness in answering.

Most of the members of our group are also governmental servants, and thus are well aware of the bureaucratic procedure and its defects. However, NASA, this immense organization that naturally has a bureaucratic arrangement, shows such flexibility that it successfully overcomes the defects arising from bureaucratic organization.

If we dared to request similar information from the U.S.S.R., we would hardly be favored with a reply, or if they decided to reply to us, they would not give us even 1/1000 of the information we received from NASA.

NASA's is the true scientific spirit, a spirit that is headed by your great country, and one that does not conceal even the failures.

Let then the Russian astronauts-propagandists keep the mockery for their own country. And let them try to imitate the Free World in the exchange of scientific information so that then they may have the right to compare the achievements of the two worlds.

Apostolos Ch. Frangos, B. A.
Scientific Rockets Research
Group on Space
Athens, Greece

No Free Enterprise

To the Editor:

I'm still chuckling over your ambivalent editorial in the July 16 issue ("Hello, Out There," M/R, July 16, p. 46) in which you express your "particular satisfaction" over the achievements of the so-called "free enterprise system" in one paragraph, then later voice apprehension that that same free enterprise system, via *Telstar*, would be "an Orwellian monster reducing the entire world to the same level of mediocrity. . . ."

Like most fanatical adherents to the so-called free enterprise system, you seem to be blind to the fact that as soon as you limit the right of a businessman to use TV time for mediocre or misleading advertising, you no longer have a free enterprise system! We haven't had free enterprise in America since Congress passed the first protective tariff, and you know it. This is what Walter Lippmann had in mind when he recently wrote that the philosophy of the Repubilcan party was a no-win philosophy because it was false. You know very well that AT&T, whose praises you were singing so loudly, is one of the most blatant monopolies in the U.S.

Frankly, you and the business community for which you write would do well to face up to the realities of life in a capitalist society, and then admit to them publicly. Then at least you'd earn public respect for being honest!

Riley Crabb
Vista, Calif.

Morality and the Moon

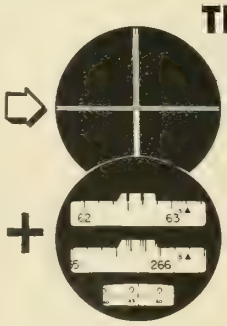
To the Editor:

Many thanks for your coverage of our paper presented at the IAS summer meetings on "The One-Way Manned Space Mission" (M/R, June 25, p. 16). It should be pointed out that we do not "urge" that the trip be conducted since it represents an extremely high risk mission, inconsistent with our moral values. The purpose of the paper is to present a technical appraisal of the mission.

The 34 ft. of lunar rubble covering the living quarters represents an upper limit, and provides a radiation shielding equivalent to the Earth's atmosphere. At the lower limit, estimates have indicated that as little as six feet of rubble covering may provide a satisfactory protection level.

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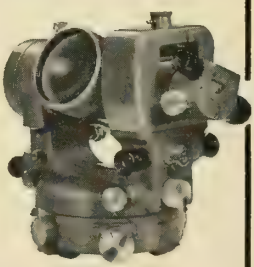


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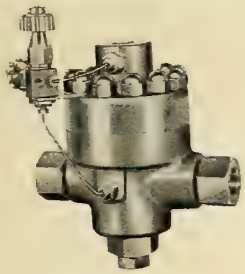
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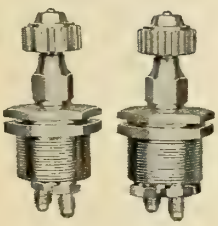
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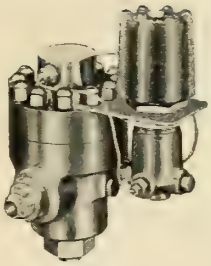
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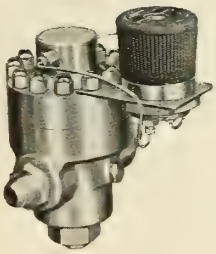


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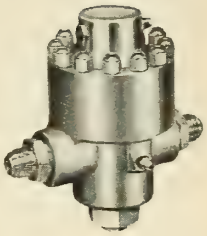
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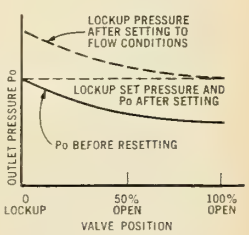
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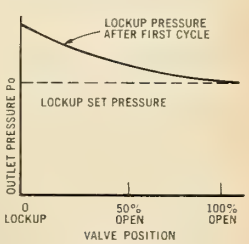
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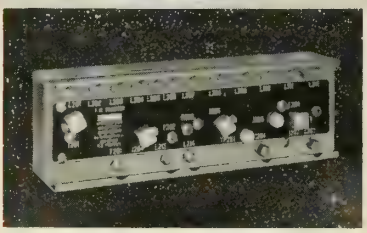
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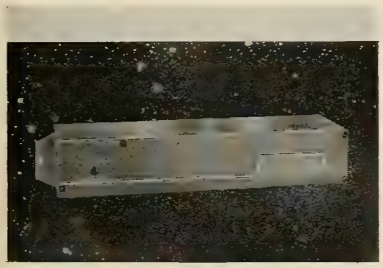
3. A specialized electronics research staff has been established in the Los Angeles area, to serve Air Force missile activities on the West Coast.

4. Hallicrafters is participating in a new R & D and manufacturing facility to be built in Chicago, for high-power microwave tubes and vacuum devices.

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- Radio Frequency Interference measurement and reduction; components.
- "Blue Flash" Projects (field electronic technical support)
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*This classic phrase was struck by President John F. Kennedy February 20, 1962, in his remarks over television welcoming Astronaut John H. Glenn, Jr., back to Earth.



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The Countdown

WASHINGTON

Zeus Assist Denied by Army

Reports that *Atlas* missiles used in the Pacific tests carry a beacon for the *Nike-Zeus* to home on are heatedly denied by the Army. The beacon, it is pointed out, is part of a miss-distance indicating system which transmits on a frequency not used by *Zeus* acquisition and tracking radars.

Senate Committee Probes Titan Charges

Charges of inefficiency, unnecessary costs and duplication of effort in construction of *Titan II* sites at Davis-Monthan AFB, Ariz., are under preliminary investigation by the Senate military preparedness subcommittee. Recent accident at the site also will be probed.

Funding Delay Worries Space Agency

Congressional delay in authorizing funds for Fiscal 1963, which began July 1, is beginning to worry NASA officials. Although the space agency now has been authorized to engage in programs at a $3.7-billion level, it can only spend at the Fiscal '62 rate until Congress acts. Major construction programs could be affected.

Congressional Action in Power Struggle

At least one congressional committee is expected to step into the battle between Air Force and Atomic Energy Commission over management of the *SPUR-SNAP-50* program, as urged last week by MISSILES AND ROCKETS. Rep. Melvin Price (D-Ill.), a member of the Joint Committee on Atomic Energy and chairman of its R&D subcommittee, tells COUNTDOWN: "We will hold hearings on the matter before this session is out."

Telstar Success is NASA Worry

Success of AT&T's *Telstar* satellite is providing some NASA officials with a new worry. They feel they may come in for unjustified public criticism if the first launch of the space agency's own *Relay* satellite later this year does not achieve the same degree of success.

NASA Content with JPL Setup

Suggestions from Congress that Cal Tech's Jet Propulsion Laboratory be made a NASA installation are meeting with no support from NASA and Administration officials. They see no cost savings from a change in the present non-profit arrangement.

Advent Replacement Costs Run High

Estimates of R&D costs for the two replacement communication satellite projects for *Advent* run between $300-400 million. This is in addition to the $170 million already spent for *Advent*. Funding in the program is expected to remain near the Fiscal '63 level of $95 million for the next three or four years.

Easing of X-20 Security

Watch for a loosening of security on the *X-20 (Dyna-Soar)* project now that it is firmly established as a research program, rather than a weapon system development effort. A new DOD-approved directive is in the works.

INDUSTRY

Titan II Production in Baltimore

Martin Co. is well along with establishment of a production line for a man-rated *Titan II* at its Space Systems Division in Baltimore. Barrel sections for the booster still will be manufactured at Denver, but Baltimore otherwise will provide full second-source production. Initial production will be for the *Gemini* program.

Successful Centaur Firing at Edwards

No announcement has been made, but a complete *Centaur* vehicle was tested in a full-duration 231-sec. firing at Edwards AFB, Calif. The run is described as the most successful in the program.

New Range Ship for the Pacific

Another range instrumentation ship will go into operation on the Pacific Missile Range in the fall of next year. Formerly the victory ship SS Seton Hall, the vessel will be converted by the Boland Machine and Mfg. Co. of New Orleans. New designation: TAGM-8.

Strike Could Delay Base Activation

A West Coast missile strike could delay activation of *Atlas F* bases. Although General Dynamics/Astronautics has given top priority to the program, activation of Schilling AFB already has slipped to the end of August. It could slip further if a strike holds up logistics support from San Diego.

New Space Capability for Bendix

Bendix Corp. has unified in a single program all of the firm's engineering and development for space navigation and for guidance, stabilization and control of satellites and other space vehicles. The new organization will combine capabilities of seven Bendix divisions.

New NASA Reporting Procedure

NASA now will insist that all contractors provide a quarterly projection of future costs. The agency believes this will aid in getting better cost estimates and also provide an important tool for cost cutting.

INTERNATIONAL

UK-1 Acts Up, Breaks Down

Telemetering of data from the *UK-1 Ariel* satellite began to break down last week. The carrier is being received without modulation, according to informants. Actual trouble has not yet been determined, but for at least a 36-hr. period, transmission was intermittent.



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Shots of the Week

An Army *Nike-Zeus* successfully intercepted an *Atlas*-launched target vehicle July 19 in the first known "kill" of a re-entering ICBM nose cone.

Launched from the Army's *Zeus* complex on Kwajalein atoll, the three-stage missile did not physically hit the target nose cone but was within the kill radius of a nuclear warhead. The *Zeus* was not armed with a nuclear warhead in the July 19 test.

Developing 450,000 lbs. thrust, the *Nike-Zeus*—the only antimissile missile under development in the U.S.—was launched at the target vehicle after the acquisition radar had picked it up and the necessary launch data had been calculated by the target intercept computer. The "kill" reportedly took place at about 200,000 ft.

In announcing the test results, DOD officials were notably restrained, reflecting their often expressed doubts about the effectiveness of the *Zeus* system. These doubts center around the ability of the system to handle a saturation attack and to discriminate between decoys and a nuclear warhead, as well as the estimated $10 billion required to install the system.

Members of Congress, in contrast to DOD, were jubilant over the success. Rep. George P. Miller (D.-Calif.) announced the test results on the floor of the House, saying that the *Zeus* test was evidence of one of the greatest breakthroughs in recent defense development.

An earlier *Nike-Zeus* test against the *Atlas* target vehicle was not a complete success, a Defense official told reporters. Asked why the earlier test was not announced, he said "we had nothing to announce."

The tests will continue in the Pacific with the target vehicles becoming more sophisticated as they progress. Decoys and radar-jamming techniques will be used to test both the *Zeus* discrimination capabilities and the effectiveness of the U.S. penetration aids program.

In other launchings:

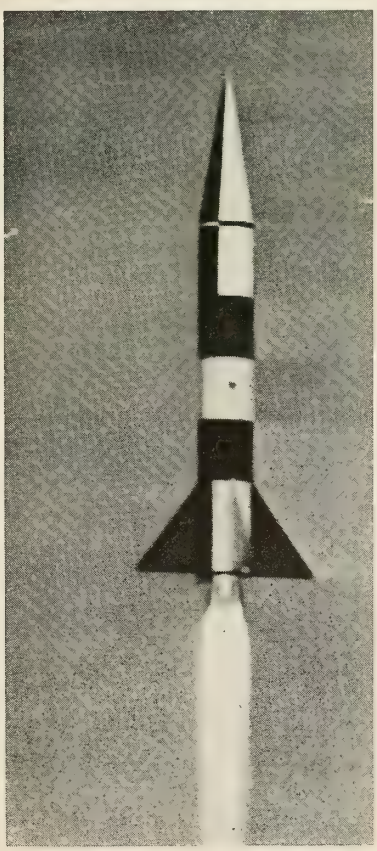
• An *Atlas-Agena B* carrying the *Mariner I* spacecraft was destroyed about three and a half minutes after liftoff from Cape Canaveral July 22. No cause for the failure of the *Atlas* booster was immediately disclosed. A backup launch of *Mariner II* is scheduled next month.

• The Air Force attempted to launch a *Blue Scout, Jr.* space probe, July 24, from Point Arguello, Calif. The probe carried a classified payload.

• The *X-15,* piloted by NASA's John McKay, made a low-altitude "slow" flight July 19 to determine the effects of heat generated on the black alloy steel (Inconel-X) skin.

Flying at 84,500 ft. at a speed of 3375 mph, McKay subjected the *X-15's* skin to an estimated temperature of 1100°F. The flight was the longest in the 61 *X-15* tests, with the engine burning for 115 sec.

• United Arab Republic on July 21 launched four single-stage rockets which UAR President Nasser said were capable of reaching Israel from Cairo. Dr. Eugen Saenger, the German rocket scientist, is said to be the man behind the new UAR rocket arm.



EL KAHER—The Conqueror—rises from Western Desert site northwest of Cairo July 21 in first public launching of an Egyptian-assembled rocket.

Two of the rockets launched—called *El Zahir (Victorious)*—are reported to have a range somewhat in excess of 220 mi. The other two—called *El Kaher (Conqueror)*—are about 40 ft. long and are said to have a range of 300 mi.

• The Air Force launched its fourth Martin *Titan II* from Cape Canaveral, July 25 on a planned 5000-mi. flight. However, the missile fell far short of its goal when the second stage failed to burn for its full duration.

The entire second stage and the nose cone fell into the Atlantic Ocean not far from the launching site.

NASA Funds Near Final Okay

A joint House-Senate conference committee has approved a Fiscal 1963 NASA authorization bill of $3,744,115,250.

The measure includes $2,957,878,000 for research, development and operations activities and $786,237,250 for construction of new facilities.

The legislation provides $43 million less than the space agency's request for $3,787,276,000.

Approval by both houses of Congress is certain.

The actual cut in program funds was $75 million, but this was reduced when the committee approved $32 million in new funds to purchase 14,800 additional acres of land at Cape Canaveral.

The $75-million reduction in R&D and construction programs included $63 million for *Nova* construction, $10 million in the lunar planetary spacecraft program and $2 million for the studies of a transportation system for the *Advanced Saturn.*

Here is a breakdown of major elements of the NASA budget request as approved by the joint committee:

—*Manned spaceflight programs*—Funds for manned spacecraft will jump by almost 800%—from $147.2 million in Fiscal '62 to $863.6 million in Fiscal '63.

Project *Apollo* funds approved total $617 million, including $345 million for the command and service modules and $123.1 million for the lunar excursion module.

For Project *Gemini* the total is $203.2 million, including $22.5 million for spacecraft engineering, $86 million for fabrication and procurement, $50 million to purchase *Titan II* launch vehicles and $21.8 million for *Atlas-Agenas.*

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In Project *Mercury,* the one-day flight series is funded at $12.1 million. Another $1 million will be used to wind up the current three-to-six-orbit flights.

—*Unmanned spacecraft*—The total budget is $263.5 million, with $151.8 million for lunar spacecraft and $89.7 million for craft which will explore the planets.

Major programs in the lunar area are *Ranger,* $44 million, and *Surveyor,* $97.3 million.

Interplanetary spacecraft programs include $9.2 million for the *Mariner R,* $73.7 million for the *Mariner B* and $6.8 million for *Voyager.*

—*Scientific, Meteorological and Communication Satellites*—Scientific exploration with orbiting satellites is earmarked for $175 million. Total authorizations for communications satellites is $85.3 million, including $16.7 million for Project *Rebound,* $19.1 million for Project *Relay,* $21.5 million for an *Advanced Relay,* $4 million for Project *Syncom* and $18.6 million for an *Advanced Syncom.*

In the weather satellite area, a total of $51.1 million is authorized. This includes $39.7 million for four *Tiros* and two *Nimbus* satellites.

—*Launch Vehicles*—The primary booster for the Manned Lunar Landing program, the *Advanced Saturn,* is budgeted at $335.1 million. Other launch vehicle programs include $249.2 million for the *Saturn C-1,* $163.5 million for *Nova,* $66.6 million for *Centaur,* $8.9 million for *Scout,* and $230,000 for *Delta.*

For a complete breakdown of NASA's R&D budget see M/R, April 9, p. 12. For similar details of its construction program budget see M/R, April 16, p. 14.

Strike Put Off 60 Days

Yielding to a presidential plea, the International Association of Machinists and the United Automobile Workers agreed to postpone for 60 days their strike against four leading missile/space companies.

A strike, the President said, would "substantially delay our vital missile and space programs and would be contrary to the national interest."

At the same time, the President appointed a three-man board to assist the Federal Mediation Board in further negotiations. Members of the board: Dr. George W. Taylor, professor at the Wharton School of Finance at the University of Pennsylvania and a member of the President's Labor-Management Advisory Board; Ralph W. Seward and Charles C. Killingsworth, both permanent umpires under the contract between Bethlehem Steel Corp. and the United Steel Workers.

The three-man board with Taylor as chairman plans to hold separate, informal meetings with management and union representatives. Formal meetings may be scheduled with both sides should this prove necessary.

The four companies—Ryan, North American, Lockheed and General Dynamics (Convair)—faced the strike July 23 because of their resistance to union demands for an "agency" shop and a supplemental benefits program. Both were accepted by Douglas Aircraft Co. in a pact signed the previous week and ratified by the union membership, July 24. (M/R, July 23, p. 11)

Under the agency shop, non-union members would be required to pay union dues by checkoff but would not be required to join the union. The supplemental benefits program would augment the unemployment benefits provided by the government.

Eleven Asked for LEM Bids

Eleven firms—all with airframe experience—have been invited to submit bids by Sept. 4 for research and development of Project *Apollo's* lunar excursion module (LEM).

The invitations to bid were extended July 25 by NASA's Manned Spacecraft Center in Houston.

The firms are Lockheed Aircraft Corp., The Boeing Co., Ling-Temco-Vought, Grumman Aircraft, Northrop Corp., General Dynamics Corp., Douglas Aircraft Co., Republic Aviation, Martin Marietta Corp., North American Aviation, Inc., and McDonnell Aircraft Corp.

The space agency also announced that potential subcontractors should contact the invited firms. The agency said that it had a limited supply of the lunar excursion module specifications and that these can be obtained by subcontractors from the Manned Spacecraft Center's Procurement Office.

The two-man vehicle will be used for launch from the *Apollo* spacecraft while in lunar orbit for the trip to the Moon's surface.

Navy Telescope Cancelled

Cancellation of the Navy's 600-ft. radio telescope at Sugar Grove, W. Va., will not affect the Air Force-managed 1000-ft. dish in Puerto Rico, AF officials told M/R last week.

Unlike the Navy's telescope, the antenna is not movable but rather is suspended over a valley, thus avoiding some of the construction

difficulties associated with building the largest movable antenna in the world. Construction on the Puerto Rico dish is nearing completion, AF officials said.

The Navy telescope was cancelled by Defense Secretary McNamara July 18 after a determination that technology had decreased the usefulness of the project and that the cost of completing the telescope would be $200 million in contrast to the original estimate of $80 million.

An ARPA program under the management of the AF's Cambridge Laboratories, the Puerto Rico dish differs in purpose from the Navy project and has not been obsoleted by advancing technology, according to AF officials. The telescope will be used for space research as well as classified defense projects. Cornell University is expected to receive a contract to operate the radio telescope for the Defense Department.

AFSC Activates Research Div.

A permanent Research and Technology Division to provide centralized planning and direction for Air Force applied research and advanced technology programs was activated at Bolling AFB, Washington, D. C., July 26, it was announced by Gen. B. A. Schriever, Commander of the Air Force Systems Command.

Provisionally activated April 4, 1962, the division—headed by Maj. Gen. Marvin C. Demler—will manage a broad field of applied research and technology for the development of advanced aerospace systems for the Air Force.

Organization of the new division is expected to be completed by July 1, 1963.

Gemini-Apollo Center Planned

A $30-million Mission Control Center for Projects *Gemini* and *Apollo* will be located at the Manned Spacecraft Center in Houston.

The Center, including its computer complex, communications center, flight simulation facility and flight operations displays, is due to be operational in 1964 for *Gemini* rendezvous flights, NASA announced.

The Philco Corp., Palo Alto, Calif., is studying a design concept for the flight information and control functions of the Center under an April, 1962, contract.

Construction supervision of the Center has been assigned by Manned Spacecraft Center to the U.S. Army Corps of Engineers.

The Mission Control Center will be used to control *Gemini* and *Apollo*



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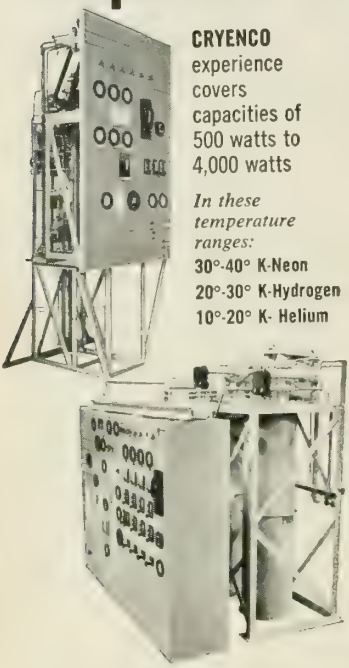
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operations just as the *Mercury* Control Center at Cape Canaveral is the nerve center for Project *Mercury* flights.

In approving the recommendation of NASA Manned Space Flight Director D. Brainerd Holmes and Manned Spacecraft Center Director Robert R. Gilruth, Webb said, "Our experience in Project *Mercury* has demonstrated that there must be a continuous interchange of knowledge of information between project officials, operations officials, and the astronauts. They will be living and working at Houston and this will make the Center continuously accessible to all involved in monitoring and directing preflight simulations as well as flight operations."

Another Go with Mariner

NASA is laying the groundwork for a second try, within 24 to 36 days, to send a *Mariner* space vehicle to Venus. A NASA spokesman in Washington gave the preliminary timetable as experts at Cape Canaveral sifted data to determine why the *Atlas-Agena* booster, attempting to lift a 446-lb. instrument package, veered off course July 22 and had to be destroyed.

Destruction was triggered only seconds before the *Atlas* booster was to have separated, but NASA officials were unable to report the exact cause of the abort. In Washington, informed observers said the explanation might be delayed or partially withheld if the cause is attributed to a malfunction in the classified Air Force *Atlas*.

The schedule of a second shot depends on whether or not the program requires significant modifications. The capsule, which was to fly within 10,000 miles of Venus, dropped into the ocean with other wreckage several hundred miles east of Cape Canaveral. Tentatively, *Mariner II* will be sent on a similar flight carrying an identical payload.

Titan Site Mishap is Minor

One man suffered arm burns and 19 others were treated for smoke inhalation as the result of a July 22 accident in a *Titan* missile silo at Davis-Monthan AFB, Tucson, Ariz.

Officials of the Martin Co., prime *Titan* contractor, termed the incident a "heavy short circuit" in an instrument console, adding that the word "explosion" was an inaccurate description of the mishap. No fire occurred.

Damage to the empty silo, which is still under construction near Rillito, Ariz., was said to be superficial. All 20 persons involved were released after treatment in a Tucson hospital. The accident reportedly happened while the men, all contractors under the U.S. Army Corps of Engineers, were making a heat and ventilation test in the silo.

This was at least the third *Titan* site accident, but Martin spokesmen declined to compare this latest one with earlier explosions at Vandenberg and Beale Air Force Bases in California. The May 24 Beale incident injured 59 and resulted in the $20-million loss of missile and silo.

Missiles To Overfly Populated Areas

Army officials have announced that, beginning in 1963, missiles will be test-fired over lightly populated areas in New Mexico.

Due to the 100-mile maximum range at White Sands Missile Range, the Army said, they will fire missiles into the range from sites further away.

The average population density of the overflight areas is 1.5 persons per square mile. The missiles will carry dummy warheads.

Brown Sees No Salary Control

There is no plan at present to place salary ceilings on top employees of non-profit research and industrial firms doing research work for the government under cost-reimbursable contracts, Dr. Harold Brown told a Congressional committee last week.

Testifying before the House Military Operations subcommittee, Brown, Pentagon R&E chief, did assert that a leveling off of salary charges might be achieved "by making it a little harder" for companies who recruit technical talent from competitors with pay incentives to get government R&D work.

Later, Defense Department Comptroller Charles J. Hitch told the committee that DOD is using 40% of its R&D funds to cover unnecessary cost overruns.

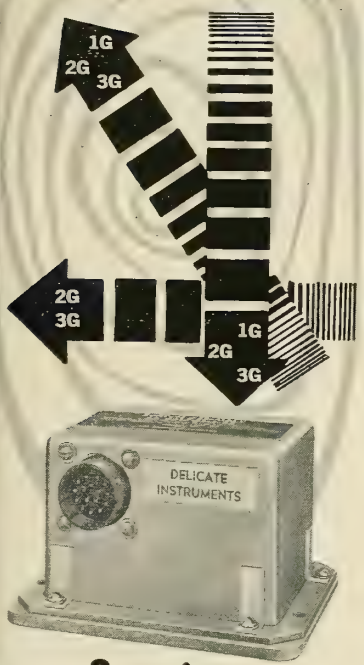
In order to protect against a contractor's "systematic effort to underestimate," Hitch said, his office has a contract with The Rand Corp. which will provide for development and installation of the program package advance planning concept.

ELDO Names Officer Slate

At a recent meeting of the European Launcher Development Organi-

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new 3-axis acceleration switch

Genisco's new GBM Series 3-axis multiple level inertia switch provides the aerospace industry with proved, new degrees of reliability and versatility. Originally designed for shock detection in a missile transport monitoring system, the GBM detects the level of shock from any direction. Separate circuits set to operate at different G inputs and on vertical, longitudinal, and transverse planes give eighteen different switching levels. The GBM is gas-damped and hermetically sealed. It has a true accelerometer response and is accurate within 5% full scale.



single-level, double-level, triple-level switches, too

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zation's preparatory group in Paris, it was agreed that the following should be offered appointments to the top posts in the new space body: secretary-general, Ambassador Renzo Carrobio di Carrobio, a member of the Italian diplomatic service holding a senior post in the Ministry of Foreign Affairs in Rome; technical director, W. H. Stephens, director-general of ballistic missiles at the British Ministry of Aviation: and administrative director: H. Costa, a high official of the West German government. The appointments are subject to confirmation by the Organization's council when it comes into formal existence.

Radiation Problem Attacked

Three possible answers to the anticipated ticklish problem of manned rendezvous with a nuclear-powered rocket were recently proposed by Robert Bussard, staff member of the Los Alamos Scientific Laboratory.

Speaking earlier this month in Cleveland at the Lunar Missions Meeting of the American Rocket Society (M/R, July 23, p. 16), he observed that the fission decay after reactor shutdown could give rendezvousing astronauts lethal radiation doses; shielding the reactor to keep the dosage down to a safe laboratory amount would make the nuclear-powered vehicle too heavy to be practicable.

Suggested solutions: (1) use a relatively cheap low-power-density reactor and throw it away before rendezvous is complete; or (2) use a similar refuelable reactor, and then throw away only the fuel elements; or (3) do not dock head-on, thereby obviating the need for any but shadow shielding.

Melpar Stretches MM Work

Receipt of possibly the largest electronics contract ever received by a Washington, D.C., area firm was announced last week by Melpar, Inc., a subsidiary of Westinghouse Air Brake Co. The $24-million follow-on production order for high-reliability circuit boards for the *Minuteman* guidance system was awarded by Autonetics Division of North American Aviation, Inc.

The new contract follows closely the announcement last March of a preliminary $6.3-million award for the circuit-board work to the firm.

Autonetics, associate prime contractor for *Minuteman* inertial guidance and control, indicated also that it was the largest single subcontract ever placed by the division.



R/M ASBESTOS-PHENOLICS

The component: ENGINE LINER

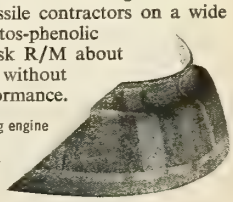
The missile: NIKE ZEUS

Solid fuel rocket engines inside the Nike Zeus missile are surrounded by super-insulating materials. Right at the hottest spots are insulation liners molded of R/M Style 42RPD Pyrotex® mat.

This asbestos-phenolic is particularly suited for duty in such hot spots. It ablates uniformly and in doing so builds up a structural char which remains in place, resisting the shock, heat and gaseous forces which act upon it. The char actually improves insulating characteristics.

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Cross section showing engine liner molded of R/M 42RPD Pyrotex® mat.

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U. S. to Spend $16.2 Billion in FY '63

Manned Lunar Landing Program Doubles NASA Budget; DOD's Biggest Boost is in Military Space R&D; AEC, Weather Bureau Share in Expansion

DURING FISCAL 1963, industry will reap the benefit of the exponential growth of the nation's space program. This sudden growth has not been limited to the National Aeronautics and Space Administration — although the fact that the space agency's budget has more than doubled in response to President Kennedy's call for a manned lunar landing in this decade is the most spectacular evidence.

The increase also affects the Department of Defense. Military space—in spite of arguments over space missions and particularly manned space missions —showed the largest single increase in DOD's Research and Development budget for the year ahead.

The Atomic Energy Commission and the Weather Bureau also shared in the $5.5-billion space program as the nuclear rocket went from small-scale reactor feasibility experiments into a full-blown stage development program, and as *Tiros* proved the value of meteorological satellites and *Nimbus* promised even greater returns.

At the same time that space programs were mushrooming, missile development expenditures were declining as the Air Force brought in its *Atlas* and *Titan* squadrons, the Army prepared to field its *Pershing* and *Sergeant* missiles and the Navy expanded its on-station *Polaris* fleet.

But this coming year will see a growth in procurement, operational and maintenance funds for most of the U.S. strategic retaliatory systems, pushing the total missile/space budget to $16.2 billion.

The status of the major missile and space programs of the individual services and NASA is reflected in detail in the pages of M/R's Sixth Annual World Missile/Space Encyclopedia, starting on page 41.

However, to indicate the scope of these programs and to attempt to show the emphasis, both in resources and priority, during the next year, M/R has prepared the following analysis.

ARMY

Almost $560 million is included in this budget for procurement of Army missiles—less than 20% of the Army's $2,674 PEMA account.

Included in these funds, however, is the initial "buy" of the Martin *Pershing*. Thus, during the current fiscal year, the Army expects to move its mobile, solid-fueled, Army-support weapon into the field—and in the latter part of the year deploy it to Europe. The budget, therefore, also includes money for the *Pershing*-carrying Chinook helicopter and the fully-tracked XM-474 vehicles for ground mobility.

RDT&E funds for *Pershing* have dropped off sharply in this year's budget with the approaching completion of the development and flight test program.

The 1963 procurement of *Sergeant* missiles—along with those funded in prior years—will completely meet the inventory objective for the Army, except for future requirements for training missiles. The solid-fueled corps support weapon will begin its deployment in the first quarter of calendar year 1964.

Other surface-to-surface weapons of the Army which will be procured this year include the *Davy Crockett* (recently test-fired in Nevada), the improved *Honest John* and *Little John* as well as the replacement of the *SS-11* antitank weapon with the *Entac*.

In the surface-to-air category, procurement will include the *Nike-Hercules, Hawk* and limited buys of *Redeye*. The *Hercules* procurement this year is expected to meet the Army's deployment objective except for tactical and training missiles. Addition of high-powered acquisition and tracking radars during the year will increase the capability of *Hercules*.

Hawk procurement will also closely approach the deployment objective while improvements to the system are expected to sharpen its capability against low-flying aircraft and tactical rockets.

Initially procured in FY '62, *Redeye* —an IR-homing, air-defense weapon for the individual soldier—will also be bought this year, but due to the poor performance of the system during field tests, it will not be procured in quantity.

RDT&E funds for Army missile development have decreased this year from $495 million in FY '62 to $447 million. The primary reason for this decrease is that the R&D funding of *Pershing* will drop $55 million and *Nike-Zeus* funding will be some $7 million less than last year. At the same time, the Army is accelerating its development of the tactical air-defense system, *Mauler*. In the past, Army missile programs took about 42% of the R&D money. This year the percentage will drop to 33.

Zeus funding ($267.5 million) will largely be spent in flight tests against AF-provided targets as well as in developing improved radars and a higher acceleration "sprint" missile.

Other Army missiles under development include *Shillelagh, Missile B*, a Heavy Antitank Assault Weapon *(HAAW)* and a Tube-launched, Optically-tracked, Wire-guided *(TOW)* antitank weapon.

Shillelagh reportedly has encountered serious guidance difficulties and is being simplified by the use of wire-guidance techniques to insure an early operational date. Bidders conferences have been held for the development of *Missile B*. However, a final contractor selection is not expected before September or October. Although funds for the development of the heavy antitank weapon are included in the '63 budget, Army officials will not release any data on the system.

Feasibility demonstrations are now being conducted by the Army on Hughes, McDonnell and Martin submissions for the *TOW* development. Results of these tests are not expected to be available for at least two months, with a final contractor selection contingent on the evaluation of the test results.

NAVY

Polaris continues to dominate the Navy's missile procurement with $421 million—a $66-million increase over FY '62—out of a total missile budget of $930 million. The total Fleet Ballistic Missile submarine program, however, has decreased from last year's $2.124 billion to $1.9 billion.

With this year's budget, the Navy will contract for the construction of six more *Polaris* submarines as well as long leadtime components for six more. By

the end of the year, Navy officials expect to have 12 submarines completed with 7-9 of these on station.

In addition, production of the 2500 mile *A-3* missile is expected to begin late this calendar year after development flight tests—scheduled to begin this month—are completed. To support the *Polaris* program, funds are also provided for support facilities in the Pacific as well as the construction of a fourth submarine tender.

To increase the position accuracy of on-station *Polaris* submarines, the Navy expects to have its *Transit* Navigational Satellite system operational in October. Six launches of *Transit* satellites are planned for the current fiscal year using *Scout* boosters. Also tentative plans have been made to include two *Thor-Able Star* launches depending on the success of the *Scout* launchings.

Sharply up from last year, the Navy's missile budget is expected to provide a complete magazine of surface-to-air missiles—*Terrier, Tartar* and *Talos*—for the 30 missile-firing ships already in the active fleet and the nine ships expected to join the fleet during the fiscal year. In addition, the Navy will continue to concentrate its procurement dollar on *Sparrow III* and *Sidewinder* air-to-air missiles, on *Bullpup* and *Shrike* (initial procurement this year) air-to-surface missiles and the *ASW* underwater-launched *SUBROC*).

In addition to development of the *Polaris A-3*, the Navy is concentrating the major part of its resources on the development of the surface-launched *Typhon*—successor to the *Tartar, Talos* and *Terrier* and designed to provide fleet air-defense against the enemy threat in the 1970s.

An extremely expensive system, *Typhon* would be deployed aboard nuclear-powered frigates—the first of which is to be contracted for this year —in two versions: a medium-range missile and a long-range missile.

However, due to the expense of the system, Secretary of Defense McNamara has said that he must know "considerably more" about the system before committing it to production.

In addition, the Navy is continuing work on the Mark 46 torpedo—expected to provide the warhead for *ASROC*, a surface-launched ASW weapon. SPASUR—the Navy's space tracking network—will receive increased support during the year in order to increase its effectiveness as part of SPADATS.

Finally, although a decision on the development of the aircraft has not been made yet, the Navy is proposing the development of a new missile system reportedly called *Condor*, for the TFX fighter. However, this program does not appear to have been approved as yet.

AIR FORCE

By the end of FY '63, the Air Force plans to have the total programed force of 13 *Atlas* missile squadrons as well as a greater part of the 12 *Titan* squadrons in place. With seven *Atlas* and four *Titan I* squadrons already turned over to Strategic Air Command, the remaining six *Atlas F* units are being checked out and installed at their hardened sites while construction for all but one of the six *Titan II* sites is scheduled for completion during the year. The two remaining *Titan I* sites will be operational by the end of the year also.

The Malmstrom AFB complex in Montana for the first wing of *Minuteman* missiles is presently some 60 days ahead of schedule and is expected to be ready when the first *Minuteman* squadron becomes operational late this calendar year. A major portion of the construction on three other *Minuteman* sites will be accomplished during this fiscal year. In all, funds are available in this budget for the procurement of 800 missiles (16 squadrons) with the option of increasing this in succeeding fiscal years.

Augmentation of the B-52 bomber force will be speeded up with the introduction in greater quantities of the air-launched *Hound Dog* missile in addition to the already-in-service *Quail* decoy and ECM vehicle. Each B-52G will be equipped with two *Hound Dogs*.

In the area of tactical missiles, the Air Force is procuring the *Bullpup*—the Navy's air-to-surface missiles. Designated *GAM-83* by the AF, the missile has been considerably improved by the addition of a pre-packaged liquid motor and a nuclear warhead. This missile *(GAM-83 B)* will begin entering the AF's tactical arsenal this year.

Delivery of an improved *Sidewinder* missile is also expected to begin this year.

Skybolt — the 1000-mile, air-launched standoff missile—will continue in development during this fiscal year and is expected to be operational in the latter half of 1964.

Titan II, on the other hand, has scored several consecutive flight test successes and the Air Force expects to have the missile operational in early 1963.

During the first part of 1962, DOD authorized the program definition phase of the *Titan III*, including the selection of contractors for development of the system. However, as yet, DOD has not given the go-ahead for the full-scaled development of the military space booster.

The *GAR-9* version of the *Falcon* family as well as the ASG-18 fire control system will continue in development at a reduced rate of spending pending a decision on the F-108 fighter-interceptor.

One of the most confusing of the AF's development programs is the *Medium Range Ballistic Missile*. A highly-mobile van-mounted IRBM, the missile would supposedly fill the gap between the 400-mile *Pershing* and the ICBM. In spite of requirements from NATO for a missile with these characteristics, DOD is reluctant to approve anything more than a program definition phase. Apparently, the political and strategic implications of a land-based NATO weapon system are more than the Secretary of Defense is ready to endorse.

Still, the Air Force has $80 million for the program definition phase, again including the selection of six or seven contractors for various parts of the system, but no approval for anything more than that.

A standoff missile for the controversial RS-70 is also under development—based on a Hughes Aircraft design.

NASA'S FISCAL 1963 LAUNCH SCHEDULE

Program	Launch Vehicle	Launch Site
JULY-SEPTEMBER, 1962		
Mariner I	Atlas-Agena	AMR
Mariner II	Atlas-Agena	AMR
Mercury (MA-8)	Atlas D	AMR
Topside Sounder	Thor-Agena	PMR
Energetic Particle Satellite	Delta	AMR
Micrometeoroid Satellite	Scout	Wallops Is.
OCTOBER-DECEMBER, 1962		
Ranger V	Atlas-Agena	PMR
Echo II	Thor-Agena	AMR
Relay I	Delta	AMR
Telstar	Delta	AMR
Saturn -3	—	AMR
Topside Sounder	Scout	PMR
Tiros VI	Delta	AMR
Polar Ionosphere Beacon	Scout	PMR
JANUARY-MARCH, 1963		
Ranger VI	Atlas-Agena	AMR
Syncom	Delta	AMR
Relay	Delta	AMR
MA-9	Atlas D	AMR
OSO II	Delta	AMR
Saturn -4	—	AMR
Centaur 2	—	AMR
Atmospheric Structure Satellite	Delta	AMR
APRIL-JUNE, 1963		
MA-10	Atlas D	AMR
Tiros VII	Delta	AMR
Ranger VII	Atlas-Agena	AMR
Apollo Boilerplate abort test	Little Joe	AMR
Nimbus	Thor-Agena	PMR
Interplanetary Monitoring Probe	Delta	AMR

In space, the Air Force expects to have two communication satellite programs under way by the latter part of this year.

Growing out of the ill-fated *Advent* program, the first will be a medium-altitude system of 40-50 satellites using multiple-launch techniques to put them in a 5000-7000-mile orbit. The second will be a fully-stabilized, full station-keeping system of 3-10 satellites at 22,000 miles. Both will use the *Atlas-Agena* as a booster.

MIDAS—the early warning satellite—has run into grave difficulties with its IR sensing systems, and has been simplified and pushed back into a development program with no provision for operational deployment.

SAMOS—a photographic and TV reconnaissance satellite—seems to have fared better. Although all information about the program is classified, it appears from pronounciations of Russia's limited missile deployment that valuable information is being obtained from the satellite. Enjoying the highest national priority, *SAMOS* may be ready to go into operational use during this fiscal year.

Discoverer—the Air Force's open-end space research program—continues to carry payloads into orbit to determine the effects of the space environment on matter. An extension of the program to include biological and manned space stations is presently being discussed, and may become a reality before the year is out.

In their drive to develop "building blocks" for space systems, the Air Force is concentrating its effort on developing the technology for *SAINT*, the *X-20 (Dyna-Soar)* and in a myriad of advanced technology programs ranging from aerospace environment to surveillance techniques.

SLAM—the nuclear-powered ramjet—appears to be getting close attention as the result of the successful series of Tory reactor tests and the evolving DOD requirement for a low-altitude system to penetrate enemy radar defenses.

NASA

NASA during fiscal 1963 will make a major effort to overtake Russia in the race for manned space flight supremacy.

The space agency—with an authorized budget of $3.7 billion—will also make the first massive down payment on the industrial development costs of the spacecraft and launch vehicles of the U.S. Manned Lunar Landing Program.

Following a six-orbit nine-hour *Mercury* flight early this fall, the agency will gear its efforts to sending an American astronaut on a day-long orbital mission.

This will equal the 17-orbit flight of Soviet Cosmonaut Gherman S. Titov Aug. 14, 1961.

If America succeeds in overtaking the Russian lead, NASA officials hope U.S. supremacy can be maintained by the upcoming two-man *Gemini* and three-man *Apollo* programs.

Soviet Union officials, however, have already indicated that they also plan a series of new flights.

The size and scope of NASA's fiscal '63 activities will be the greatest in its history:

—Design of the *Apollo* spacecraft will be finalized. This will signal a real start on industrial fabrication. Delivery of the first F-1 and J-2 engines is scheduled for late in the year. This will enable the space agency to begin mating the engines into the stages of the *Advanced Saturn* booster which will launch the *Apollo* spacecraft on its lunar-landing mission.

A reactor to power the *NERVA* nuclear engine will be selected. This will mean that design of the *RIFT* nuclear rocket stage can begin. Studies leading to an orbiting space laboratory will be completed and industrial development should begin shortly after the end of the fiscal year.

—Twenty-eight major launches are scheduled including the first flights in 11 separate meteorological, scientific and communication programs. These include such major satellites and spacecraft as *Mariner, Relay, Syncom, Nimbus, Topside Sounder,* and boilerplate *Apollos.*

—NASA will contract to industry some 90% of its $3.7-billion Fiscal 1963 authorized programs. In the manned spacecraft area, $617 million is earmarked for the *Apollo* spacecraft. The command and service modules under contract to North American Aviation Inc. are budgeted at $345 million. *Apollo's* third module, a two-man lunar-landing excursion vehicle, will be funded at an approximate $120 million level.

Selection of a contractor for its development will be made in October-November, 1962.

NASA has been authorized to spend $203 million on Project *Gemini.* The major share, $86 million, will be spent on design and fabrication of the two-man spacecraft. Approximately $72 million will be spent on launch vehicle procurement, including $50 million for the *Titan II* booster and $21.8 million for the *Atlas-Agena* which will be used during rendezvous flights. The *Mercury* program, which will be completed in Fiscal 1963, will cost the space agency $13 million.

For a detailed breakdown of NASA's Fiscal '63 budget and activities see p. 15; M/R, April 9, p. 12, and M/R April 16, p. 14.

WEATHER BUREAU

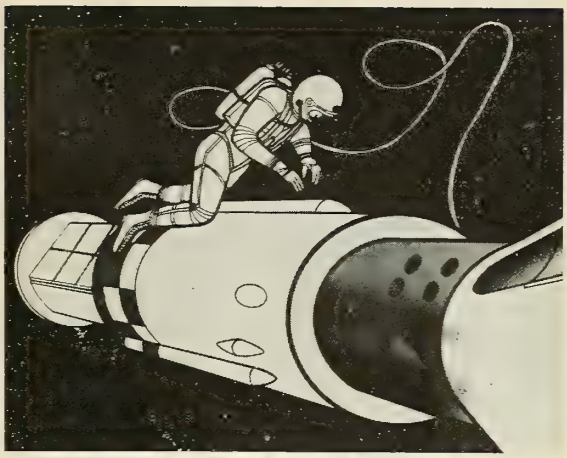
Three weather satellites will be launched in Fiscal '63 as the Weather Bureau moves closer to a worldwide meteorological satellite system. The Bureau has requested a budget of $45 million, $31.8 million of this mainly for procurement of spacecraft and launch vehicles for the *Nimbus* program. Data acquisition and communication services would be funded at $7.65 million, and $5.53 million is earmarked for data processing and technical management.

AEC

The Atomic Energy Commission's primary activity in the space field in Fiscal '63 will be the development of reactors for nuclear powerplants for NASA's Project *Rover,* the Air Force's Project *Pluto* and various satellite programs. Its total Fiscal '63 budget request in this area is $180 million—including $74.8 million for the nuclear rocket stage *Rover* program, $29 million for the *Pluto* ramjet missile program and $76.4 million for the satellite small power sources.

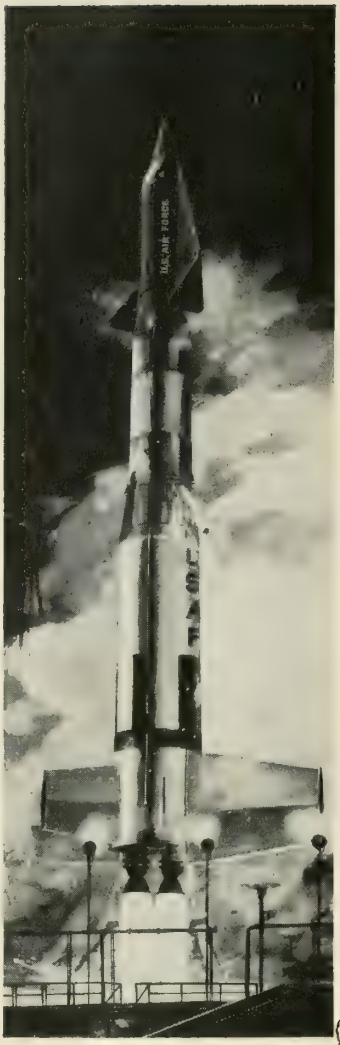
Crewman Outside Gemini

NASA recently released for use on television this cartoon of a crewman of the Gemini spacecraft working outside his capsule. It was the first public acknowledgment that Gemini astronauts may leave their cabin.





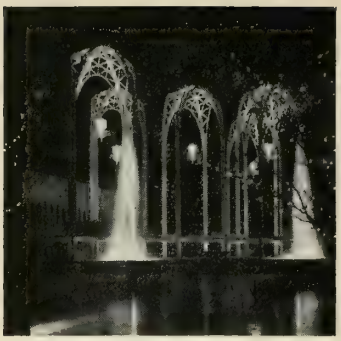
Saturn Launch Vehicle



Dyna-Soar Space Glider



Minuteman ICBM



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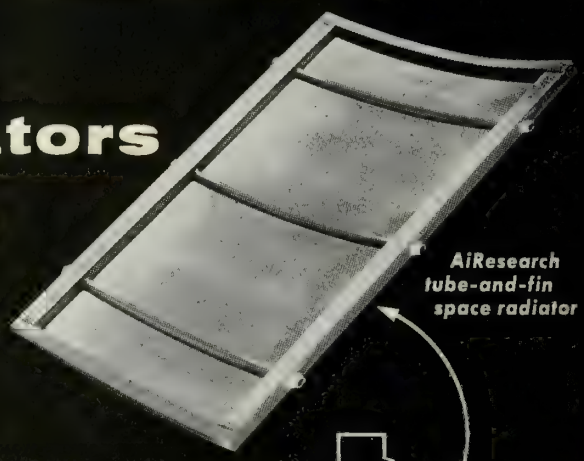
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Phone: PR 2-1000 or TWX AH 5327

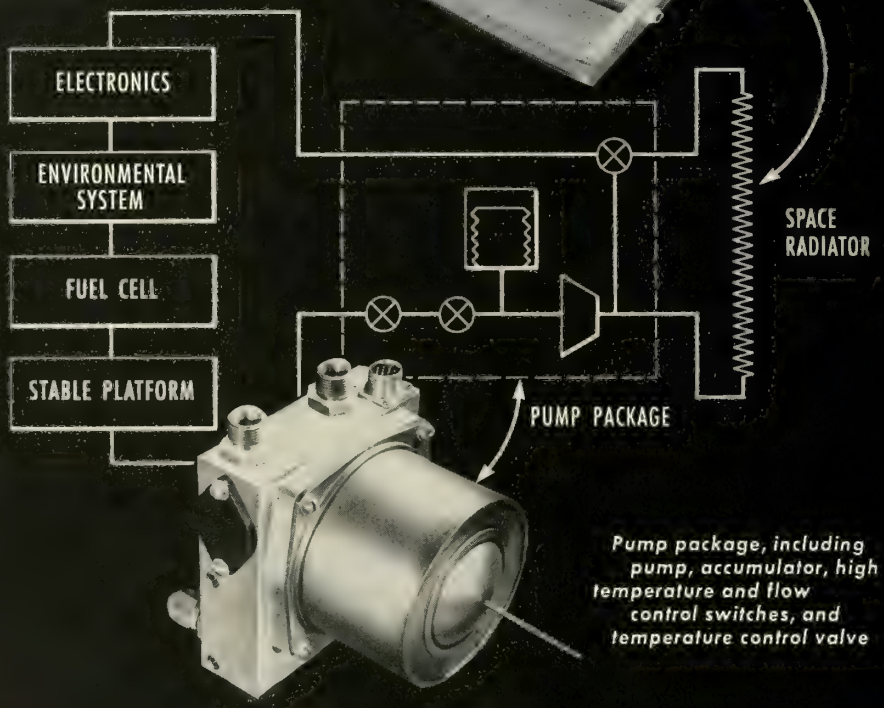
See Us at WESCON, Booths 2041-2042

ASTRODATA INC.
ANAHEIM, CALIFORNIA

Circle No. 6 on Subscriber Service Card

Reliable space radiators for satellite cooling





Garrett-AiResearch has designed, fabricated and tested lightweight space radiators, utilizing proven hardware concepts throughout. Active radiator systems can cool electronic equipment, fuel cells, stable platforms and environmental systems operating from 400°F to cryogenic temperatures.

AiResearch is foremost in space radiator design and manufacturing, and is highly experienced in weight optimization techniques, meteoroid protection, transient temperature analysis, fabrication techniques and emissive coating characteristics.

Present AiResearch space radiator development and production programs include systems for both manned and unmanned space vehicles. Other types of space heat transfer experience include the Project Mercury and Dyna-Soar systems.

AiResearch has more than 20 years of experience in the design, development and manufacture of heat transfer equipment for aircraft, missiles and space vehicles. Your inquiries are invited.

GARRETT

AIRESEARCH MANUFACTURING DIVISIONS • *Los Angeles 9, California • Phoenix, Arizona*

Systems and Components for:

Aircraft, Missile, Spacecraft, Electronic, Nuclear and Industrial Applications

Circle No 7 on Subscriber Service Card



Inland Model T-0701B D-C Servo Motor capable of continuously developing 10-watts shaft output at 5400 rpm.

Only one cubic inch is all the space you need to put this direct-drive torquer to work in precision instruments and servo systems where space, weight and reliability are critical factors.

No other motor of comparable size can come close to equalling the torque output and rapid acceleration of this miniature torque motor. Its torque-to-inertia ratio is 35,000 radians per second squared . . . at least 10 times higher than equivalent gear train servo motors. Results? Faster, more accurate response. Freedom from backlash and other problems associated with gear mechanisms.

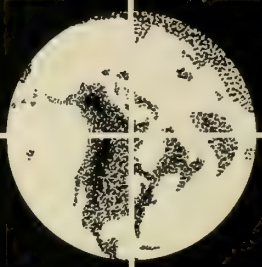
Where can you use it? You'll have ideas of your own after you've evaluated all the specifications. However, here are a few suggestions. Driving a potentiometer in a null-seeking device. Driving a pen or stylus in a data plotter. Driving variable capacitors and inductances in a tuning circuit. Positioning other components in similar equipment.

Complete specifications will be rushed to you by return mail. Why not write for them today?

INLAND MOTOR CORPORATION
A SUBSIDIARY OF
KOLLMORGEN CORP.
NORTHAMPTON, MASS.

Circle No. 8 on Subscriber Service Card

solving the information problem



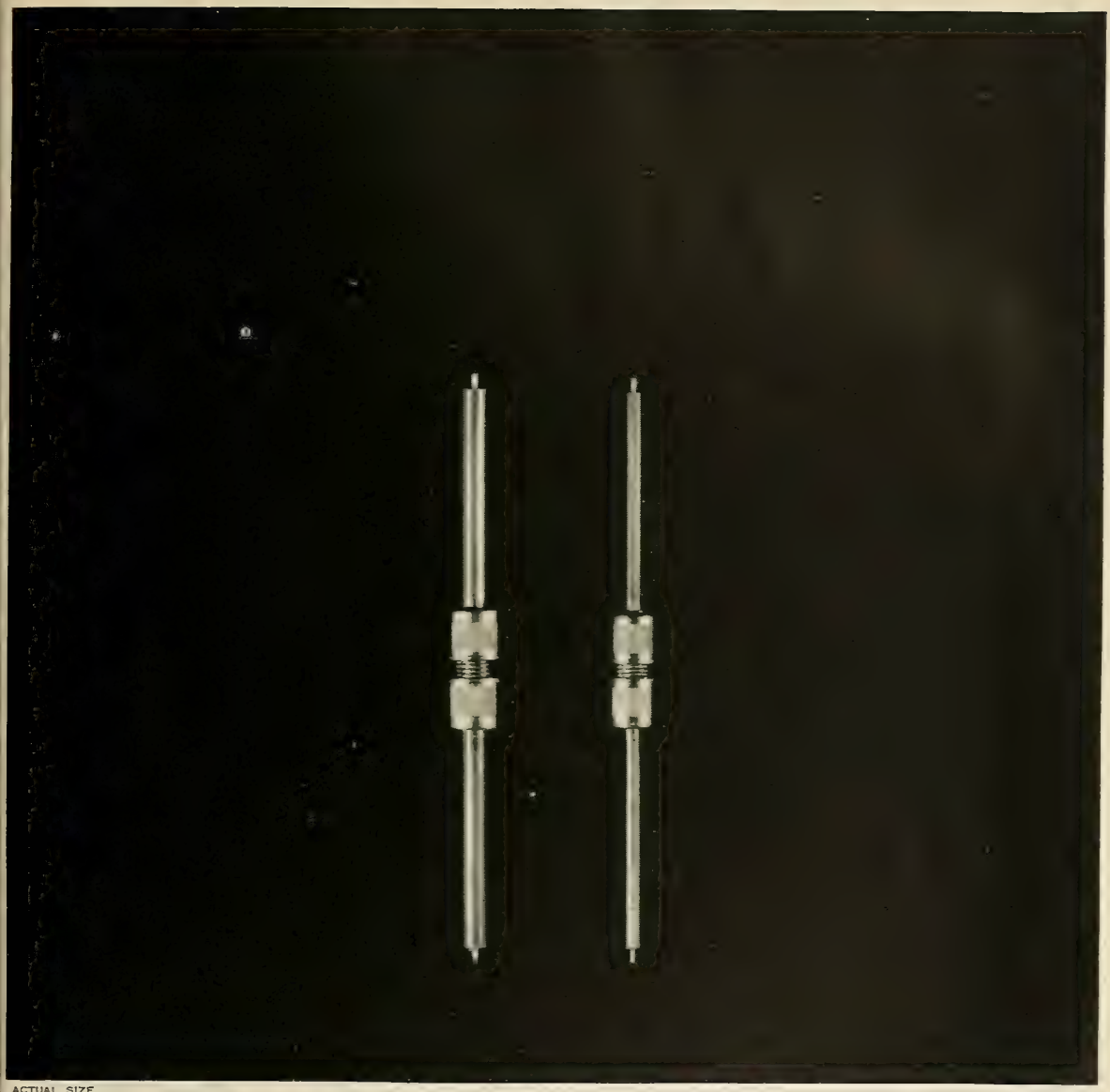
. . . **FROM INNER TO OUTER SPACE** Itek applies a blend of skills in Information Technology to the management of critical data. A novel panoramic-photographic technique for seismological recordings . . . a tracking camera with a 20-foot focal length for aerospace instrumentation . . . a high-resolution, display system for long-distance transmission and manipulation of graphic/digital information . . . a comb-filter spectrograph for ultra-precise analysis of Doppler effects . . . a thermodynamic analysis of environmental disturbances for high-acuity, aerospace photo/optical systems . . . these are but a few of the programs in the current spectrum of Itek activity. May we apply this advanced capability for research, design, development, and precise fabrication to **your** information problem?

Write for: "a blending of skills in information technology", **to Dept. MR-120.**

Itek

Itek Corporation
10 Maguire Road
Lexington 73, Massachusetts

Circle No. 9 on Subscriber Service Card



ACTUAL SIZE

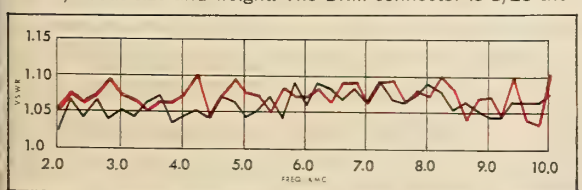
We have two new r-f connectors. They are wee ones.

They are designed to replace N series connectors in the 1 to 10 KMC frequency range where size, weight, and low VSWR ratings are critical factors.

The larger small one is the BRM. It terminates .140 semi-rigid cable either by threading or by threading and soldering. The smaller small one is the BRMM. It is for a .085 semi-rigid cable.

Talk about low VSWR ratings. Look at these curves. The black one is for the BRM; the red one is for the BRMM. The maximum VSWR is less than 1.1:1 over the frequency range of 1 to 10 KMC.

Now, about size and weight. The BRM connector is 1/28 the size of its N series counterpart. And it weighs 1/38 as much. The BRMM unit is 1/48 as large as the N series connector, 1/70 as heavy. You might call them miniatures. They are.



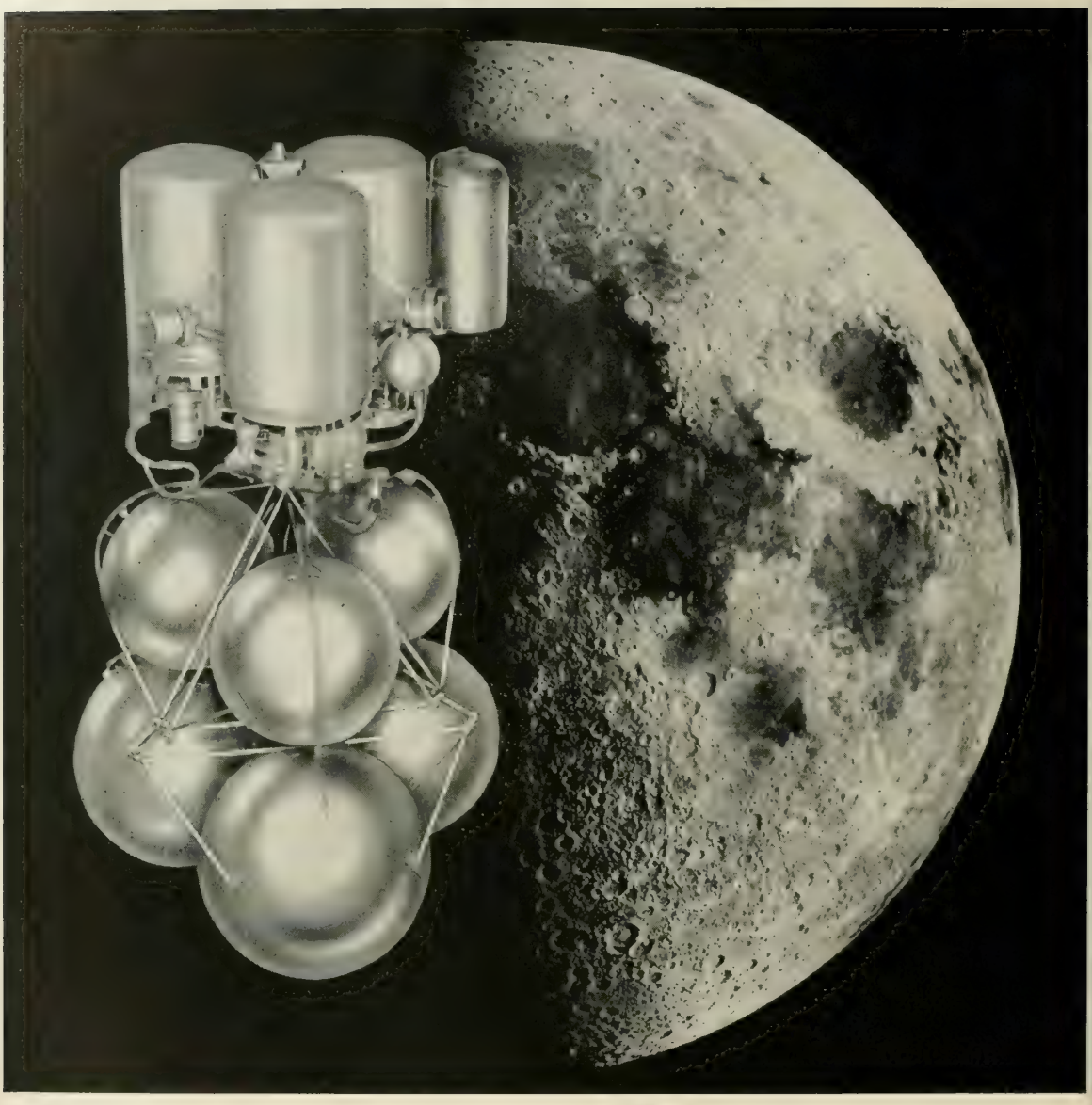
These precision r-f environmental resistant electrical connectors are machined from brass and heavily gold plated over silver underplate. The center dielectrics are electrical grade Teflon. They show high performance and excellent durability.

Developed at the Research Laboratories Division of Bendix, this new series of r-f connectors has been thoroughly production designed by Scintilla Division for maximum user satisfaction. Possibly you have an application in which the use of our new r-f connectors would be advantageous. Tell us about it. Or, write us in Sidney, New York, for technical data.

Scintilla Division

THE Bendix CORPORATION

Circle No. 10 on Subscriber Service Card



A fuel cell for Apollo

This is a model of a fuel cell designed by Pratt & Whitney Aircraft—the company chosen to develop a fuel cell system for Apollo, America's first manned lunar craft. The Apollo spacecraft will be built for NASA by North American Aviation.

The hydrogen-oxygen cell will supply power for environmental conditioning, communication, instrumentation, and scientific equipment. In addition to generating electricity, the fuel cell will provide water for Apollo's three-man crew.

Pratt & Whitney Aircraft

DIVISION OF UNITED AIRCRAFT CORP

EAST HARTFORD, CONN.

Pratt & Whitney Aircraft's fuel cell is far more efficient than conventional power systems. During tests, cells have demonstrated efficiencies of 70 to 80 per cent.

The fuel cell has a significant role in space. Moreover, it promises to be a significant power source on earth. Pratt & Whitney Aircraft is currently studying fuel cell power systems for such applications as remote-site power, vehicle propulsion, commercial power generation, and other industrial tasks.

INTEGRATED CAPABILITIES

FOR SPACE-AGE CRYOGENICS

Integrated capabilities underscore Air Products vital role in space-age cryogenics.

Today, these capabilities are being put to work in all areas of cryogenics. From large-scale plants that produce liquid propellants . . . to miniaturized, closed-cycle infrared and maser coolers. From propellant loading systems for missiles and rockets . . . to advanced cryogenic "hardware" for storing and handling cryogenic liquids during space flight.

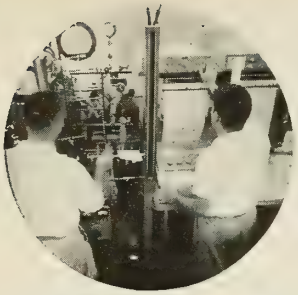
And integrated capabilities from a single one-Company source mean that Air Products can move from conceptual stage to economically feasible components and systems in record time.

Sound reasons why, when the challenge is cryogenics, Air Products is first.

Air Products and Chemicals INC.

Allentown, Pennsylvania

DEFENSE AND SPACE DIVISION



RESEARCH AND DEVELOPMENT

Defense- and space-oriented R&D extends from relatively short-range projects aimed at solving specific customer problems to longer-term programs that point the way to major improvements in cryogenic technologies and to cryogenic "futures" barely discernible today.



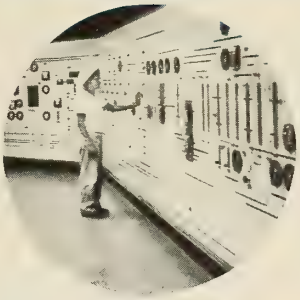
SYSTEMS ENGINEERING

Proved experience in many technological disciplines — plus overall coordination of personnel, data, and facility resources — enables Air Products to engineer critical-performance systems for any customer requirements.



DESIGN AND FABRICATION

Standard and custom components of Air Products design incorporate simplicity, reliability, compactness, and ease of maintenance. Proprietary fabrication techniques permit new latitudes in design and manufacture.



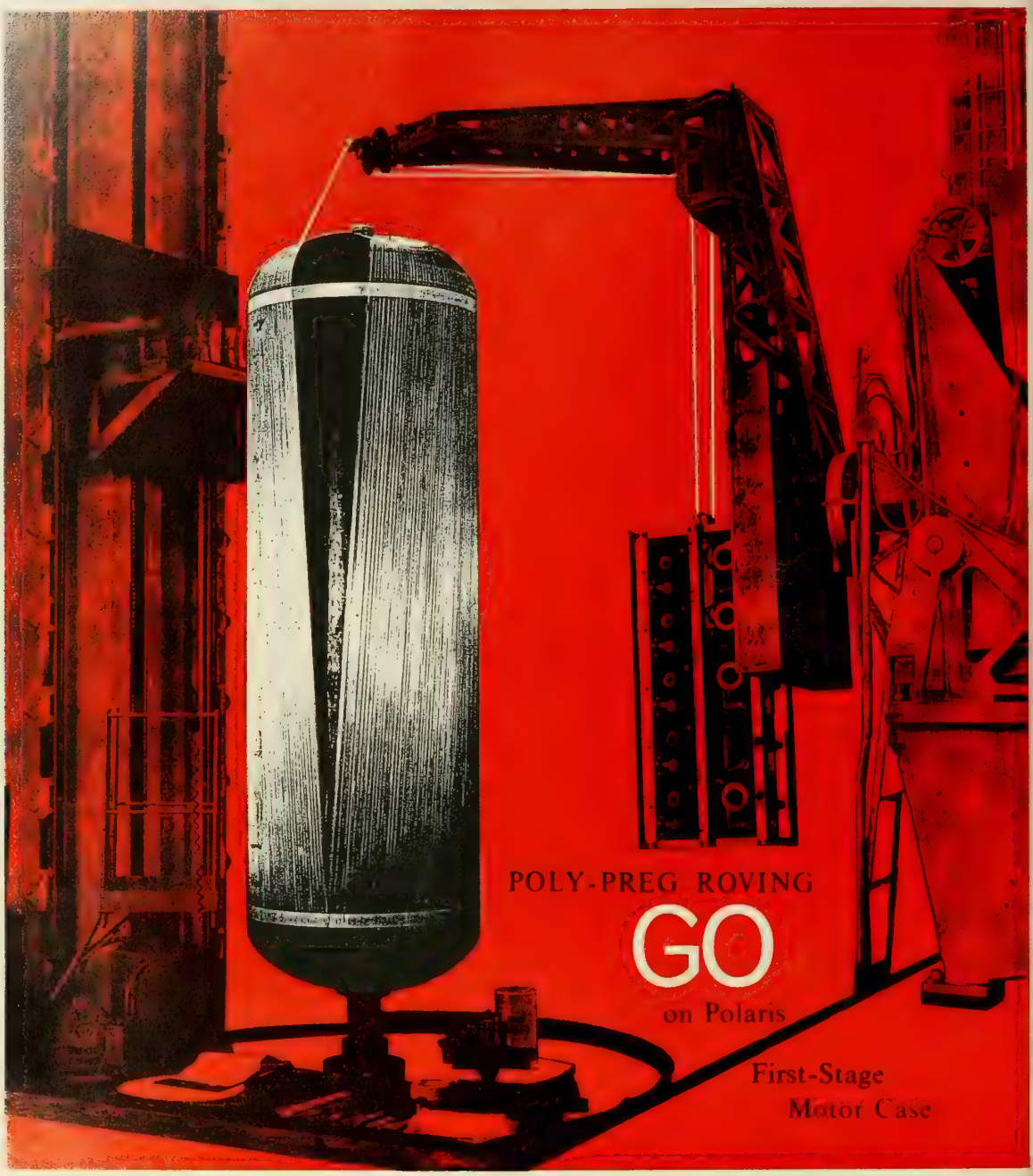
CONSTRUCTION AND OPERATIONS

Experienced teams of engineers build cryogenic facilities of any size or capacity. Feedback of operating data from Air Products plants throughout the world leads to further advances in design, engineering, and fabrication.



MANAGEMENT

Integrated capabilities from a single Defense and Space Division team assure speed, economy, and performance on every assignment . . . from conceptual stage to a complete cryogenic facility.



Cooperative R & D by Aerojet-General and U.S. Polymeric has resulted in the use of Poly-Preg, pre-impregnated glass roving, for filament winding of the Polaris A-3 first-stage motor case.

here are the reasons . . .

PRODUCTION - Poly-Preg roving is advanced to the B-stage, greatly speeding the filament winding operation. Resin baths and drying stages are eliminated; cure-cycle time and problems are minimized. Filaments stay in place as they are layed-up because of the slight tack in the material.

QUALITY-CONTROL - Poly-Preg glass-to-resin ratios are held to tight tolerances, impregnation is thorough and even, mechanical and environmental properties are consistent. Roving is thoroughly inspected and tested *before* it is committed to the structure. Production reproducibility is assured.

PERFORMANCE – Poly-Preg roving assures the high strength-to-weight ratio of the precision-wound, solid-propellant motor case that is credited with improvement of missile range and performance.

Request Poly-Preg Fact-File on your letterhead, indicating areas of interest. Address to U.S. Polymeric, Santa Ana, California.

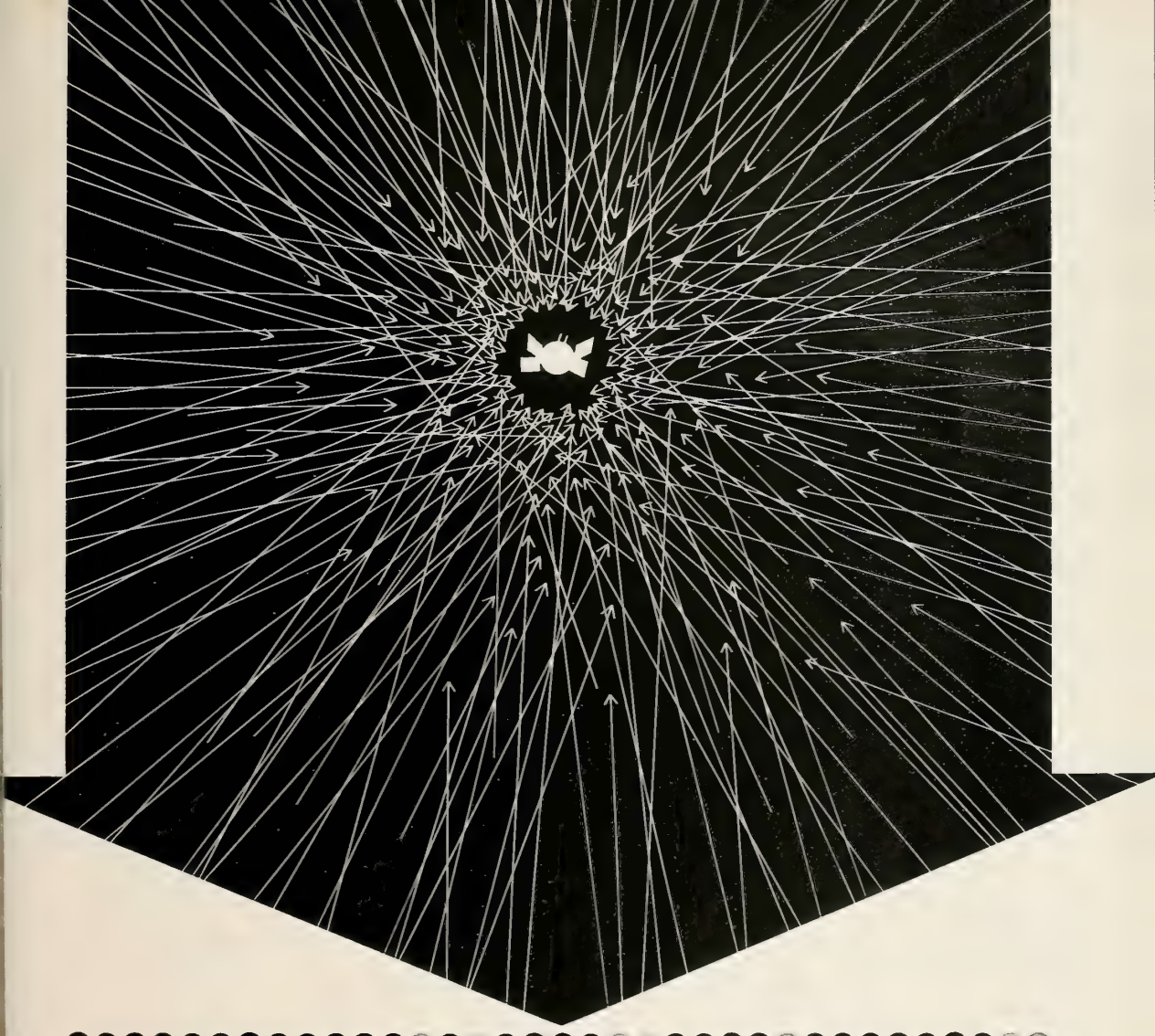
U.S. POLYMERIC Chemicals, inc.

STAMFORD, CONNECTICUT
SANTA ANA, CALIFORNIA
UTRECHT, HOLLAND

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mp62100

Circle No. 12 on Subscriber Service Card



HOW TO LISTEN TO 160,000 SPACE MESSAGES–INSTANTANEOUSLY!

A satellite in orbit has a lot to tell. It sees the birth of a hurricane, feels the bombardment of radiation, peers into new space highways. Then it hurls this information to earth in the form of millions of electrical impulses. A Beckman system gathers and translates them to a common language, is capable of delivering 160,000 messages every second–without missing a one.

With a similar Beckman system you can check a prototype aircraft through its wind tunnel tests–improve on design long before actual flight. Or run continuous checks on a petroleum refinery–assure the quality of industrial output and the safety of workers. Other Beckman instruments analyze the mystic potions of a jungle witch doctor, balance the color in television receivers, and monitor the air in nuclear submarines. Beckman instruments, systems, and components are at work throughout the world in laboratories, production lines, and defense installations.

Remarkable what you–and a Beckman system can do.

If you have a problem in analysis, measurement, or control, write to our Director of Marketing.

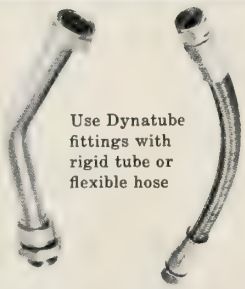
Beckman® INSTRUMENTS, INC.
Fullerton, California

Circle No. 3 on Subscriber Service Card



No Leakage Problems With DYNATUBE Fittings

The Dynatube® fitting employs a new concept which assures freedom from leakage in high performance systems handling the most difficult mediums, such as hot gas or helium. There are only two parts — shoulder and nut. The self-energizing seal is integral with the shoulder. Dynatube uses no rings, nothing extra to work loose, get lost or leak. It is the lightest, most compact fitting available for high performance applications. ¶ Method of attachment of Dynatube fittings may be in accordance with your specifications. ¶ Dynatube fittings deserve your careful investigation. Ask your Resistoflex field engineer for more information or write Resistoflex Corporation, Roseland, N. J., for Bulletin DY-1A.



RESISTOFLEX
RELIABILITY

Circle No. 4 on Subscriber Service Card



RAYTHEON will build APOLLO Guidance Computer

NASA has selected Raytheon's Missile and Space Division to produce the digital guidance computer for the APOLLO manned lunar exploration program. This computer, located in the spacecraft, will serve as the mission nerve center during the entire APOLLO flight. It will receive the outputs of each of the guidance system's sensors.

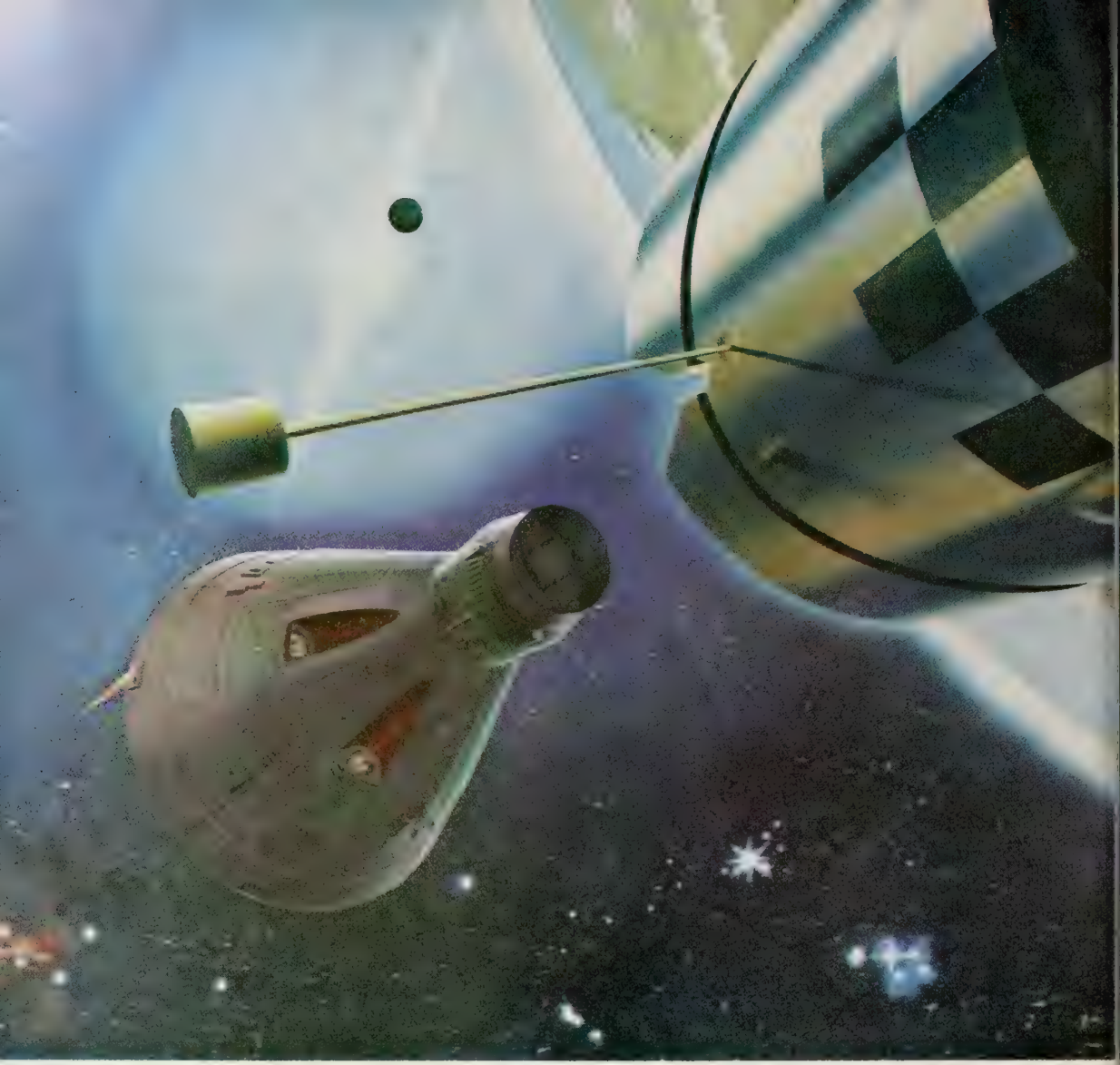
Data will be processed by the computer for automatic control of certain flight functions and for presentation to the crew to permit the optimum exercise of human intelligence during the mission. The computer will be used for all phases of the APOLLO mission.

Under its NASA contract, Raytheon will provide engineering support on the computer design to the M.I.T. Instrumentation Laboratory, which has design responsibility for the complete APOLLO guidance system. In addition, Raytheon will produce the computers which will be used on APOLLO flights.

The selection of Raytheon for this key role in the APOLLO program is but one indication of Raytheon's rapidly expanding space program and demonstrates that in the space age, as in the past, Raytheon means Excellence in Electronics.

Engineers or scientists interested in a challenging career in Raytheon's space and missile programs are invited to contact Mr. W. F. O'Melia, Raytheon Company, Missile and Space Division, Bedford, Massachusetts.

RAYTHEON



RENDEZVOUS CONTROL: *By Astronaut*

Primary control responsibilities during Gemini rendezvous and docking operations will be assigned to the Astronauts. Man, with his ability to see, analyze, reason and judge, will be fully utilized for this important phase of America's first spacecraft rendezvous operation.

Gemini is a two man, extended mission, orbital rendezvous and docking spacecraft now being designed and built for the National Aeronautics and Space Administration by McDonnell.

Rendezvous in space can have several applications in speeding America's space exploration efforts. Rendezvous will permit launching of multiple payloads with two or more smaller boosters rather than one large vehicle. With such techniques it will be possible to assemble large space stations, ferry space crews and supplies, refuel and/or assemble chemical upper stages for deep space missions, and refuel re-usable nuclear upper stages for deeper space explorations.

Space Rendezvous, the key to a quickened pace in manned space exploration, is another facet of manned space flight being pioneered by McDonnell.

MCDONNELL

F4H and F-110A Fighter and Attack Aircraft • RF-110 Reconnaissance Aircraft • Mercury, Gemini, Asset and Aeroballistic Spacecraft • Talos and Typhon Missile Airframes and Engines • Electronic Systems • Automation

MCDONNELL AIRCRAFT • ST. LOUIS

SIXTH ANNUAL

Missiles and Rockets

WORLD MISSILE/SPACE ENCYCLOPEDIA

1962

Compiled and Edited by the Staff of Missiles and Rockets

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MERCURY WITH ESCAPE TOWER

Mercury (NASA)

TYPE: First U.S. Manned Spacecraft

MISSION: Carry one man on Earth-orbital flights lasting up to 10 hours

STATUS: R&D

PRIME CONTRACTOR: McDonnell

WEIGHT: 4000 lbs. plus (including escape tower); 2000 plus on impact

GUIDANCE: Minneapolis-Honeywell, stabilization system; Bell Aerospace, system manager

AUXILIARY POWER: Batteries

PROPULSION SYSTEM: Escape rockets, solid; retro rockets, solid; control system, liquid

BOOSTER: Atlas D

REMARKS: First manned suborbital flight, May 5, 1961, by Lt. Cmdr. Alan Shepard, USN; 2nd manned suborbital flight July 21, 1961, by Capt. Virgil "Gus" Grissom, USAF; first U.S. manned orbital flight Feb. 20, 1962, by Lt. Col. John Glenn, USMC, 2nd manned orbital flight May 24, 1962, by Lt. Cmdr. Scott Carpenter, USN. One and perhaps two 3-to-6-orbit flights planned for late summer, 1962 and early 1963.

UNITED STATES

Spacecraft



APOLLO



GEMINI

Apollo (NASA)

TYPE: Three-man Spacecraft

MISSION: Manned lunar landing; ferry vehicle for manned space station

STATUS: R&D

PRIME CONTRACTOR: Command and service modules, North American; lunar excursion vehicle contractor not selected

GUIDANCE: Astro-inertial with radio inertial backup; systems management, MIT Instrumentation Laboratory; associate contractors AC Spark Plug, Raytheon Co., Kollsman Instrument Co., Sperry Gyroscope

TELECOMMUNICATIONS: Collins Radio Co.

CONFIGURATION: 3-modular spacecraft. Weight 85,000 lbs.; diameter, 13 ft..; command module, 10,000 lbs.; 12 ft. hgt., Service, 23 tons, 23 ft. high; lunar excursion vehicle, 15 tons, 20 ft. high

ENVIRONMENTAL SYSTEM: AiResearch Manufacturing Co.

HEAT SHIELD: Avco Corp.

AUXILIARY POWER: Fuel cell, Pratt & Whitney

PROPULSION SYSTEM: Escape motor, Lockheed, solid; reaction control, Marquardt Aircraft; service module propulsion, Aerojet-General, liquid; escape tower, Thiokol Chemical Corp., solid

BOOSTER: Advanced Saturn

REMARKS: First lunar landing expected in 1967-1968. Earth-orbital flights of boilerplate models scheduled for 1965. Test flights of lunar-orbit rendezvous configuration in 1965-1966 using Saturn C-1B booster. Circumlunar flights 1966-67. Lunar orbit rendezvous will be used. Two-man excursion vehicle will detach from Apollo spacecraft in lunar orbit to make Moon landing

Gemini (NASA)

TYPE: Two-man Spacecraft

MISSION: Carry two men on orbital flights lasting up to one week. Test orbital rendezvous feasibility

STATUS. R&D

PRIME CONTRACTOR: McDonnell

HEIGHT: 7 ft.

WEIGHT: 4000 lbs. on orbital flights, 6000 lbs. during rendezvous

GUIDANCE: Rendezvous radar, Westinghouse; spacecraft, all inertial, Minneapolis-Honeywell

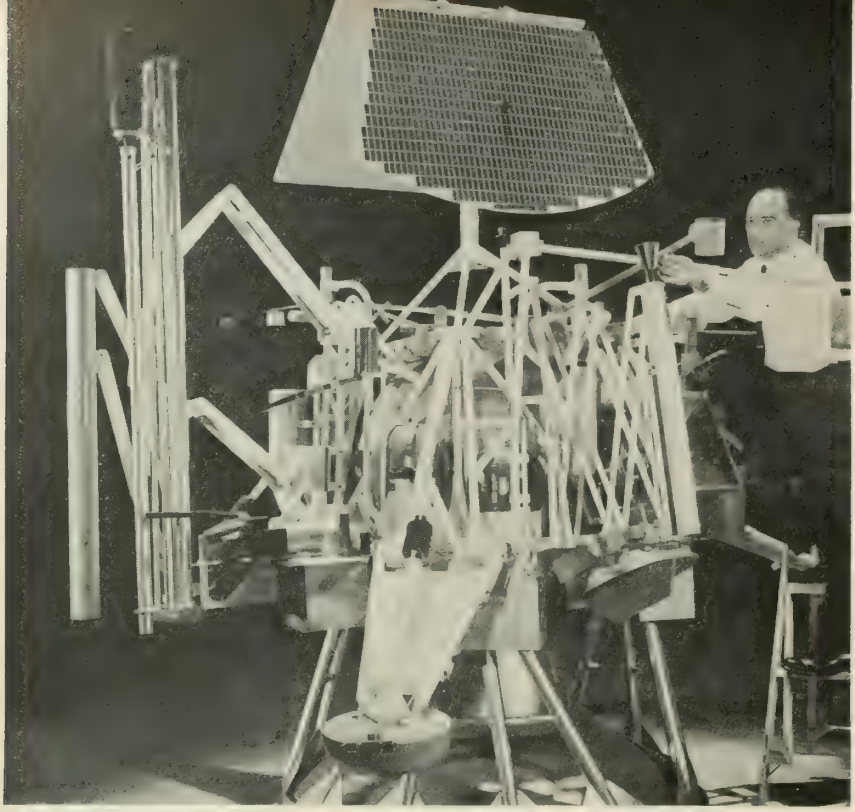
PROPULSION: Spacecraft, liquid, Rocketdyne

ENVIRONMENT SYSTEM: AiResearch

POWER: Batteries

BOOSTER: Titan II; Agena B will be used during rendezvous missions. Atlas will launch Agena B into orbit

REMARKS: Twelve to fifteen flights scheduled late 1963-1965. Flight with chimpanzee and astronaut planned. All orbital rendezvous flights will be manned.



RANGER

Aerospace Plane (Air Force)

TYPE: Manned spacecraft, capable of operating both in the atmosphere and in space

STATUS: Study and component development

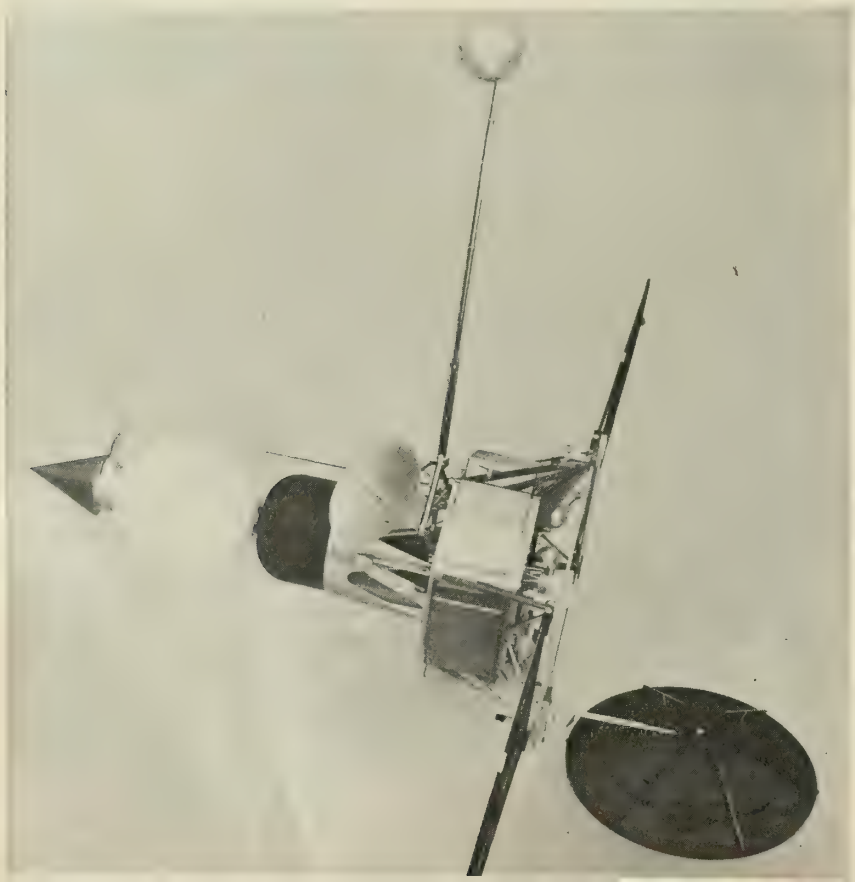
PRIME CONTRACTOR: No contracts announced

PERFORMANCE: Turbo-ramjet-rocket capable of taking off from the surface of the Earth, accelerating to orbital speeds, de-orbiting and landing. Minimum life of 100 flights is reportedly a requirement for system

PROPULSION SYSTEM: Combination turbo-ramjets for speeds up to Mach 8; Rocket-powered for higher speeds; air-collection techniques could allow significant weight reduction by enabling the system to liquefy oxygen for its rocket engine

REMARKS: Both NASA and the Air Force have expressed interest in a recoverable space booster of this type. AF has estimated that with an approved and adequately funded program ASP could be operational by about 1970

SURVEYOR



Ranger (NASA)

TYPE: Lunar hard-landing spacecraft

MISSION: 300-lb. instrumented capsule rough-landed on the Moon. Before impact, TV cameras to take pictures of lunar surface

STATUS: R&D

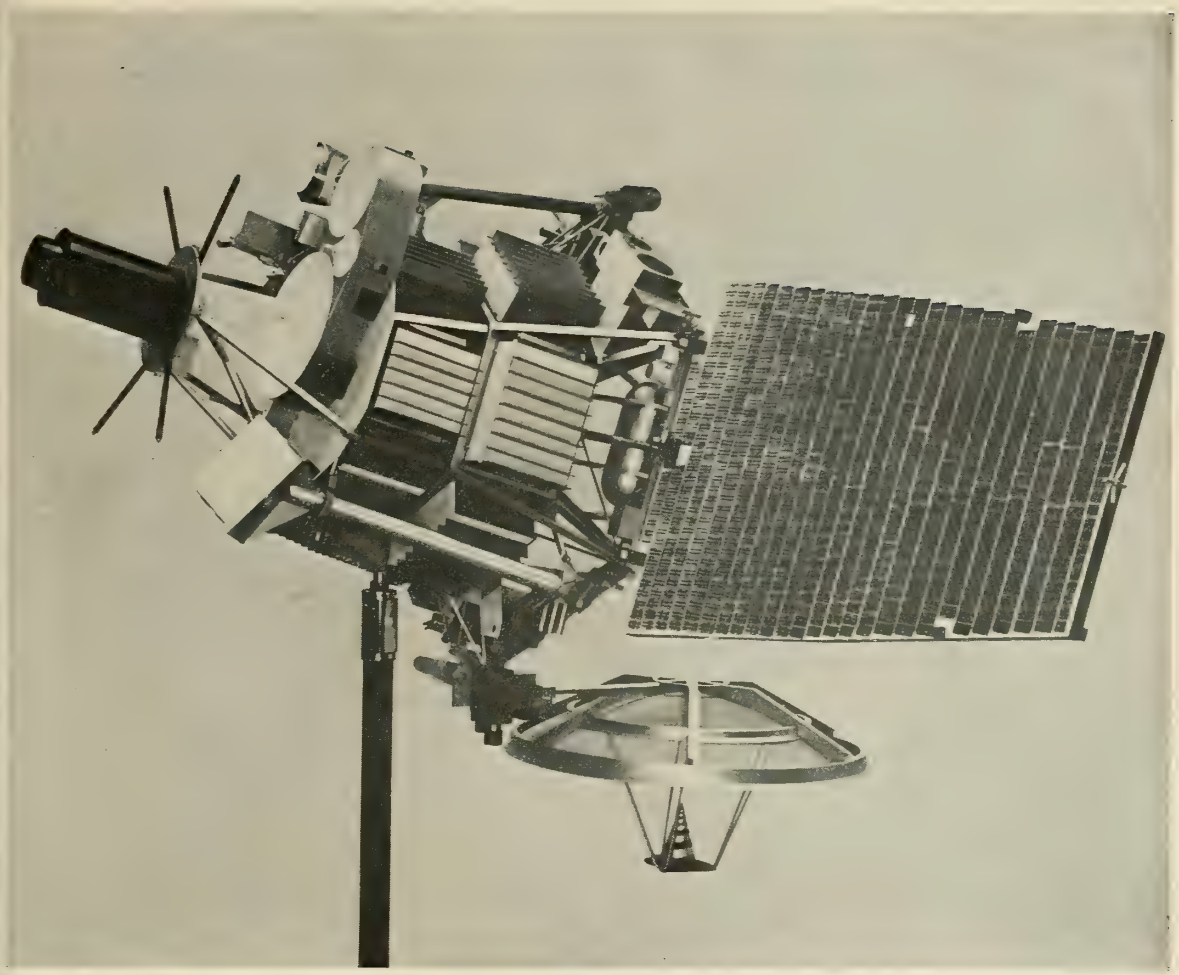
PRIME CONTRACTOR: JPL, prime; Aeronutronic, capsule; Hercules, retrorocket

INSTRUMENTATION: TV cameras, seismometer

POWER UNITS: Solar cells

BOOSTER: Atlas-Agena

REMARKS: First two Rangers failed to launch from orbit. Ranger III launched Jan. 26, 1962, failed to impact on the Moon, went into solar orbit; Ranger IV impacted on the Moon April 26, 1962. Ranger V scheduled for next October. Four more scheduled in 1962-63



MARINER I

Mariner (NASA)

TYPE: Unmanned interplanetary spacecraft

MISSION: 450-lb. spacecraft for unmanned scientific exploration flights to the vicinity of Mars and Venus. Advanced version also under development

STATUS: R&D

PRIME CONTRACTOR: JPL

CONFIGURATION: Mariner R will weigh 450 lbs.; Mariner B will weigh over 1000 lbs.

INSTRUMENTATION: Radiometer, fluxgate magnetometer, particle radiation instruments. Instrumentation will change from mission to mission. Mars mission could include ultraviolet spectroscope and infrared spectrometer

BOOSTER: Atlas-Agena

REMARKS: Twelve shots planned. First two Venus fly-by shots planned for July-September, 1962. Six Mariner B flights in 1963. Two in 1964 will use Atlas Agena B, '64 and '65 will use Centaur launch vehicle

Mercury 18-orbit (NASA)

TYPE: Modified Mercury Capsule

MISSION: 18-orbit one-day manned orbital flights

STATUS: R&D

PRIME CONTRACTOR: McDonnell

WEIGHT: 4000 lbs. plus (including escape tower); 2000 lbs. plus on impact

AUXILIARY POWER: Batteries

PROPULSION SYSTEM: Escape rockets, solid; retro, solid; attitude control, liquid

BOOSTER: Atlas D

REMARKS: First flight, summer, 1963; three more planned. Modifications include removal of periscope and redundant communication system and addition of more batteries and life support systems

Surveyor (NASA)

TYPE: Lunar soft-landing spacecraft

MISSION: Soft-land 750-lb. spacecraft on the Moon. Also take pictures of lunar surface during lunar orbital flights

STATUS: R&D

PRIME CONTRACTOR: Hughes Aircraft Co.

INSTRUMENTATION: 100-300 lbs. of scientific instruments: Sterox color television cameras, spectrometer, lunar surface drill, X-ray spectrometer, gas chromatograph, magnetometer, plasma probe, lunar atmosphere gauge and radiation detector

POWER UNITS: SNAP 11, The Martin Co.

BOOSTER: Atlas-Centaur

REMARKS: First Moon flights scheduled mid-1964. Seven soft-landing vehicles planned. Five lunar orbiters to transmit pictures of the surface also scheduled

Voyager (NASA)

TYPE: Unmanned Interplanetary Spacecraft

MISSION: 2400-lb. unmanned Mariner follow-on spacecraft to orbit Mars and Venus and to inject a capsule to the surface

STATUS: Study

PRIME CONTRACTOR: JPL

INSTRUMENTATION: Not determined

BOOSTER: Saturn C-1

REMARKS: Design and development to begin this year. First flight 1965. Mars orbital flight scheduled in 1966

X-15 (NASA-Air Force-Navy)

TYPE: Manned Rocket Plane

MISSION: Provide data for super-speed flight. Role now expanded to include testing of spacecraft components and space research. Current re-entry high angle of attack flights providing basic flight data for X-20 program

STATUS: R&D flight-testing

PRIME CONTRACTOR: North American Aviation Inc.

PERFORMANCE: Speed, 4000 mph; altitude, 100 miles

FRAME: System Contractor—North American. Length 50 ft. Launch weight, 31,275 lbs.; landing weight 12,971 lbs. Wingspan 22 ft.

GUIDANCE: Inertial flight data system—Sperry Gyroscope; adaptive flight control electronics—Minneapolis-Honeywell

POWER UNITS: System contractor—General Electric

BOOSTER: System contractor—Thiokol. Propellent—LOX and liquid ammonia. Thrust 57,000 lbs. Type XLR-99; XLR-II engine develops 16,000 lbs. thrust

REMARKS: Powered flights in progress; plane #1 has hit Mach 3 and more than 136,500 ft. with XLR-II engine. Plane #3 set new unofficial altitude record of 314,750 ft. Plane #1 set new unofficial speed record for manned powered flight of 4159 MPH June 27, 1962

X-15



X-20 (Air Force)

TYPE: Manned boost-glide spacecraft

MISSION: Demonstrate feasibility for positive controlled re-entry and recovery from orbit

STATUS: Development

SYSTEMS MANAGER: Aeronautical Systems Div., AF Systems Command

PRIME CONTRACTOR: The Boeing Co.

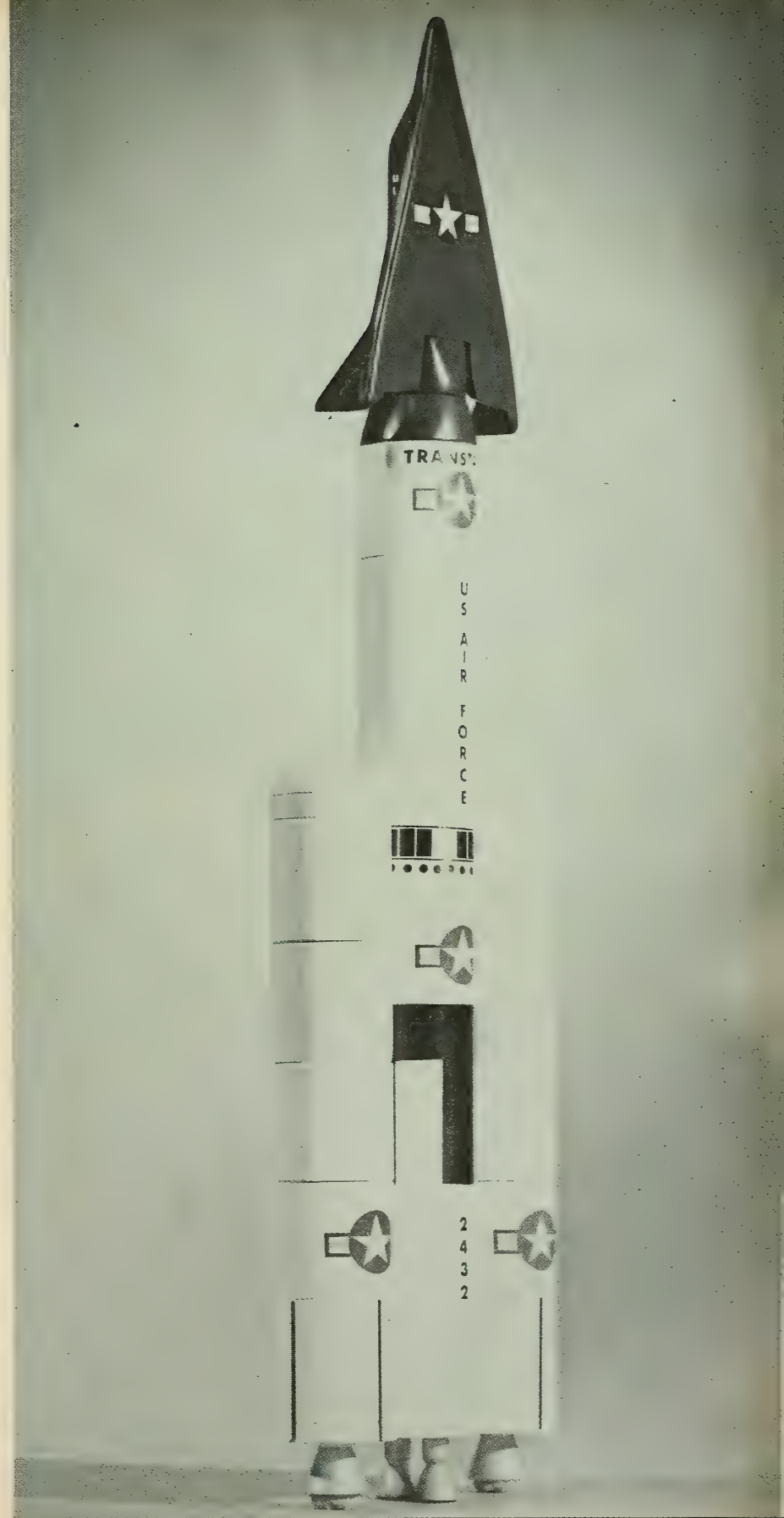
FRAME: System Contractor—Boeing; Configuration — Delta-winged glider; Weight—about 10,000 lbs.; Materials — refractory metals, ceramics and high nickel alloys; radiation-cooled structure

GUIDANCE: System Contractor—Associate prime (primary) and secondary inertial guidance—Minneapolis Honeywell; adaptive flight control electronics—Minneapolis Honeywell

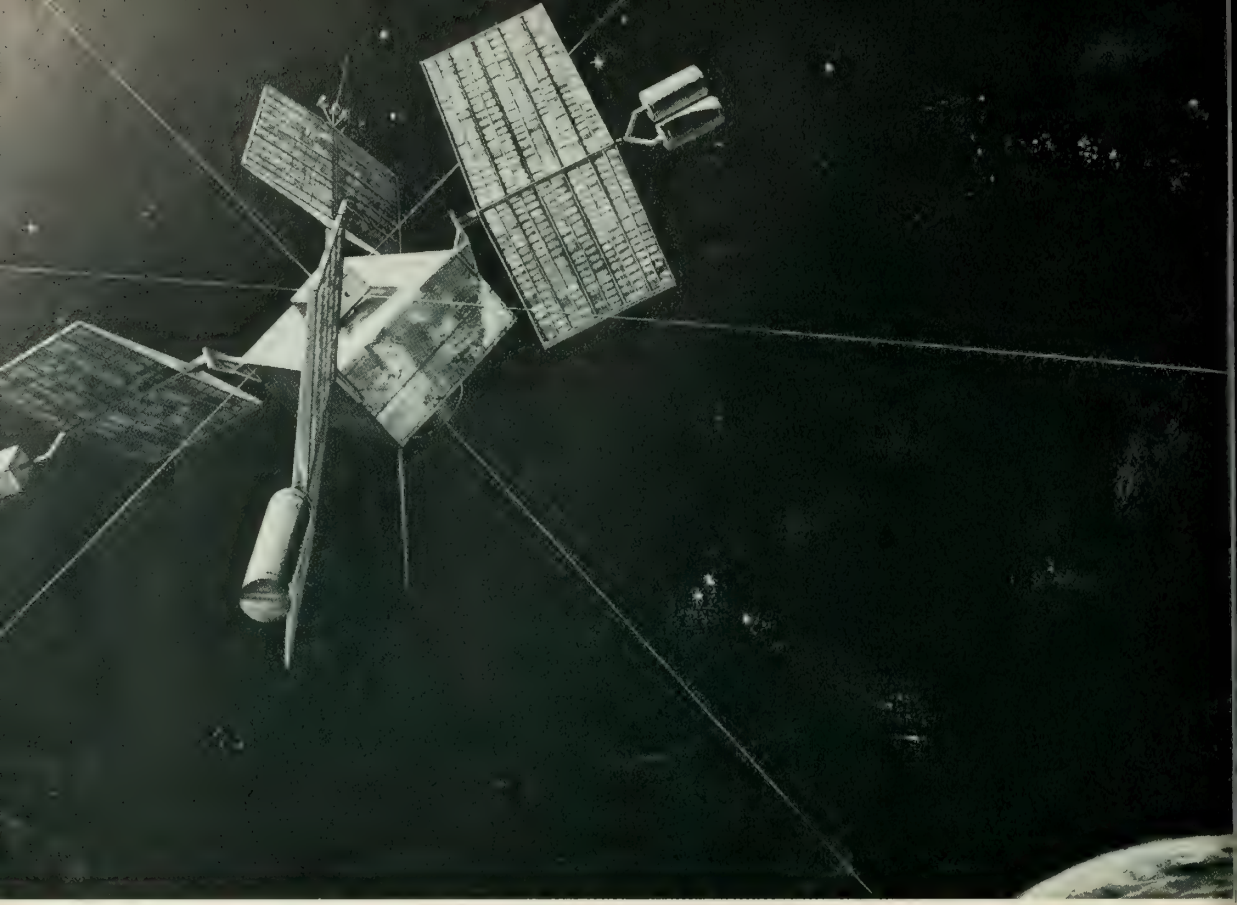
AUXILIARY POWER: System Contractor—Sundstrand; Type—gaseous hydrogen-oxygen unit

BOOSTER: Titan III

REMARKS: Program re-oriented in December, 1961, to eliminate suborbital flights; name changed to X-20 from Dyna-Soar to more accurately reflect the vehicle's research mission; first flights scheduled for 1965; air-drops from B-52 likely in late 1963 or 1964



X-20
ATOP
TITAN III



ARENTS

Satellites

Advent (see High-Altitude Communications Satellite; Medium-Altitude Communications Satellite)

Aeros (NASA)

TYPE: Meteorological Satellite

MISSION: 24-hour Earth-stabilized weather satellite, TV cameras with variable focus. Will form backbone of meteorological satellite system

STATUS: Study

PRIME CONTRACTOR: No contracts announced

PERFORMANCE: 22,300-mile orbit will permit continuous coverage of storms and cloud cover

INSTRUMENTATION: Both wide- and narrow-angle TV cameras

POWER UNITS: May use SNAP 50

BOOSTER: Atlas-Agena or Centaur

REMARKS: First flights in 1964 or 1965. Development of prototype hardware will be accelerated in Fiscal 1963

Anna (Navy)

TYPE: Geodetic satellite

MISSION: Provide a triangulation point in space for determining distances and positions on Earth; continue geodetic measurements of Earth

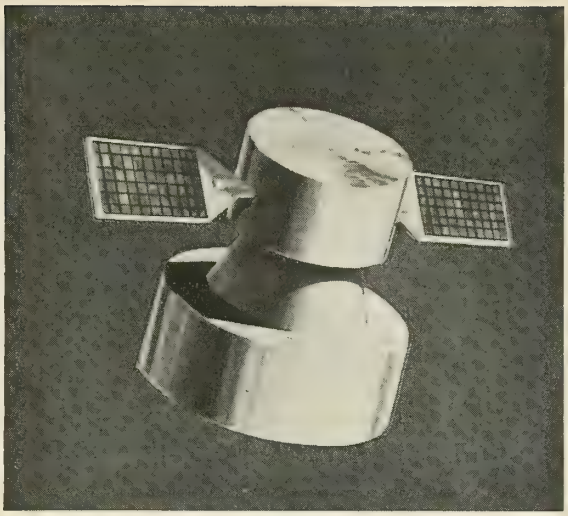
BOOSTER: Thor-Able Star

PRIME CONTRACTOR: Bureau of Naval Weapons/Applied Physics Lab

FRAME: Shape—36-in. aluminum sphere (with solar cell belt, 48 in.); Weight—355 lbs.

INSTRUMENTATION: Flash tube experiment—USAF Electronics Systems Div./Edgerton, Germeshausen & Grier, Inc.; Type—Two sets of xenon flash tubes; Function—Produces a series of five light flashes about 20 times a day to provide triangulation point. Secor Experiment—USA Corps of Engineers/Cubic Corp.; Type—CW transmitter (162-324 mc) for geodetic measurements and 54-216 mc for refraction studies; Function—Interrogated on six or seven passes each day for range determination based on Doppler shift observations

REMARKS: First ANNA launch May 10 failed when Able-Star failed to ignite; second launch scheduled late this summer; ANNA is an acronym for Army, Navy, NASA, Air Force



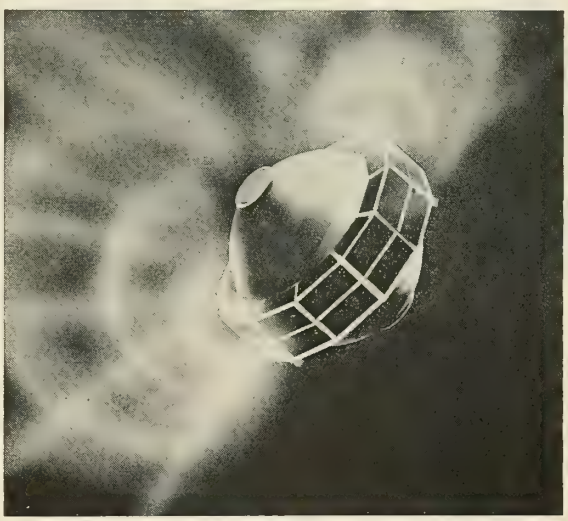
AEROS

Arents (ARPA)

MISSION: Gather data on environment and radiation in space at the 24-hour, 22,000-mi. orbit (part of the Vela Hotel program)

PRIME CONTRACTOR: General Dynamics/Astronautics

REMARKS: Three payloads are to be built as part of this program; with the delay in the Centaur launch vehicle, another booster probably will be chosen to put the Advanced Research Environmental Test Satellite into orbit (originally it was to be carried "piggy back" on a NASA payload)



ANNA

Discoverer (Air Force)

MILITARY DESIGNATION: Part of WS-117, designated 622 A

TYPE: Military satellite test bed

STATUS: Operational

PRIME CONTRACTOR: Lockheed Missiles & Space Co.

PERFORMANCE: Orbit—Capable of varied orbits depending on mission

CONFIGURATION: Length — 19.2 ft.; Diameter—5 ft.; Weight—about 1700 lbs. all dimensions, except the diameter increase 1/3 to 1/2 depending on the payload

SPACE BOOSTER: Atlas-Agena B; Thor-Agena B

PAYLOAD: Re-entry Vehicle—General Electric; Type—Capsule; Length—27 in.; Diameter—33 in.; Weight—about 300 lbs.

REMARKS: Test bed for subjecting materials, components, bioastronautical experiments or techniques to the space environment; program has been extended; before the secrecy directive in March, 38 Discoverers had been launched; Record—26 achieved orbit, 11 recoveries (7 air, 4 sea)

Echo (NASA)

TYPE: Inflated balloon passive communications satellite

MISSION: Reflect radio signals off 135-ft. inflatable sphere in a 645-mile Earth orbit

STATUS: R&D

PRIME CONTRACTOR: NASA

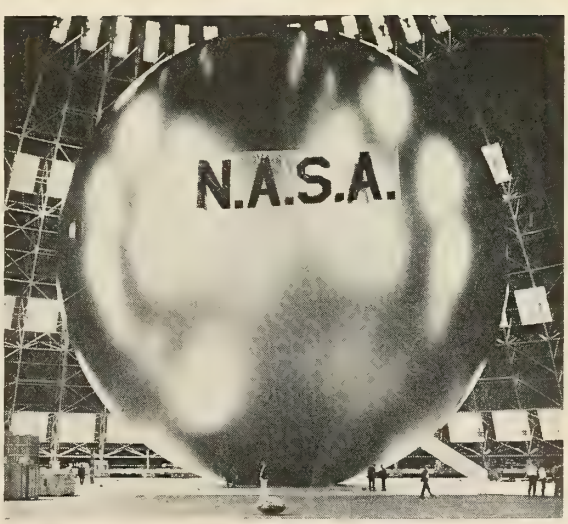
FRAME: Mylar plastic and aluminum foil laminate

INSTRUMENTATION: Tracking beacons on sphere

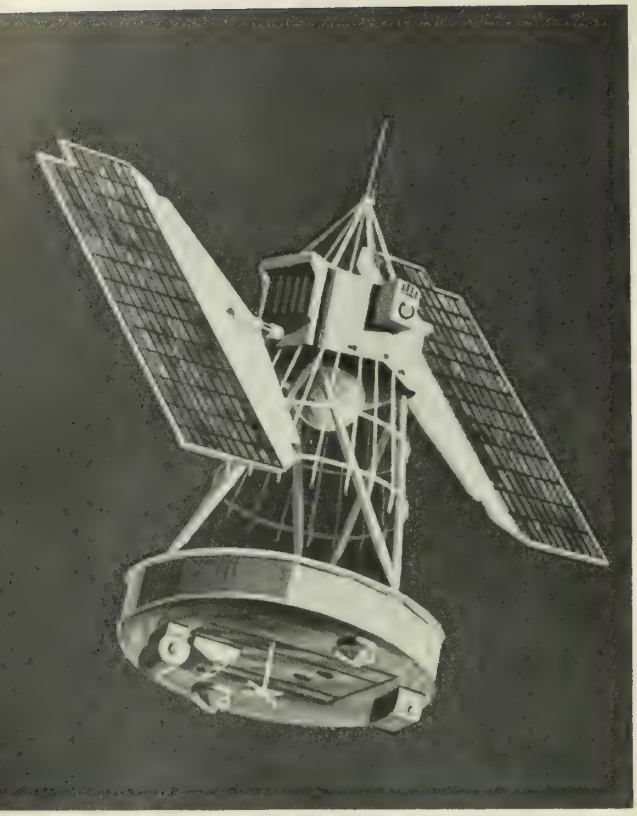
POWER UNITS: Batteries and solar cells

BOOSTER: Thor for ballistic tests; Thor-Agena for orbital flights

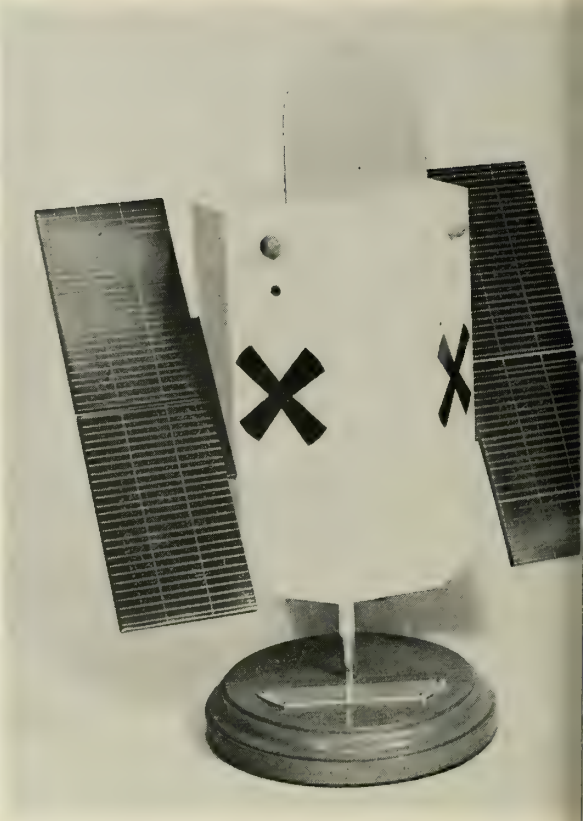
REMARKS: Echo I in orbit since Aug. 12, 1960; Echo II Jan. 1962, failed to orbit; two ballistic shots planned this year from AMR and an orbital launch from PMR. Functioning of sphere will be tested by monitoring its reflectivity to radio waves by measuring its radar cross section



ECHO



NIMBUS



OAO

High-Altitude Communications Satellite (Air Force)

TYPE: Communications Satellite

STATUS: Development

PRIME CONTRACTOR: No contracts announced

PERFORMANCE: Orbit — about 22,000 mi., but not necessarily stationary; Operational system—3-10; Type—Wide bandwidth, active repeater; Weight—500 lbs.

SPACE BOOSTER: Atlas-Agena D

PAYLOAD: Wide bandwidth communications equipment with encryption and anti-jamming capabilities

SUPPORT EQUIPMENT: Advent ground stations at Fort Dix, N.J., and Camp Roberts, Calif.

REMARKS: One of the two programs initiated by DOD after cancellation of Advent in June; similar to NASA's advanced SYNCOM; Program responsibilities — Defense Communications Agency, interface problems; Air Force, satellite system; Army, ground stations; initial operational capability expected by 1964, fully operational system in 1966

Medium-Altitude Communications Satellite (Air Force)

TYPE: Communications Satellite

STATUS: Development

PRIME CONTRACTOR: No contracts announced

PERFORMANCE: Orbit—5000-7000 miles; Polar; Weight—less than 150 lbs.; No. of satellites for operational system—40-50; Multiple launch technique to be used

PAYLOAD: Narrow bandwidth, voice and teletype communications equipment

SUPPORT EQUIPMENT: Advent ground stations at Fort Dix, N.J. and Camp Roberts, Calif.

REMARKS: One of the two programs initiated by DOD after cancellation of Advent in June; remarkably similar to NASA's advanced medium-altitude system; Program responsibilities—Defense Communications Agency, interface problems; Air Force, satellite system; Army, ground stations; economics problematical if multiple-launch cannot be perfected; initial operational capability expected in 1964, fully operational by 1966

Midas (Air Force)

MILITARY DESIGNATION: Part of WS-117, designated 239 A

TYPE: Early-Warning Satellite

STATUS: Development

PRIME CONTRACTOR: Lockheed Missiles & Space Co.

PERFORMANCE: Orbit—300-3000-mi. orbit; polar

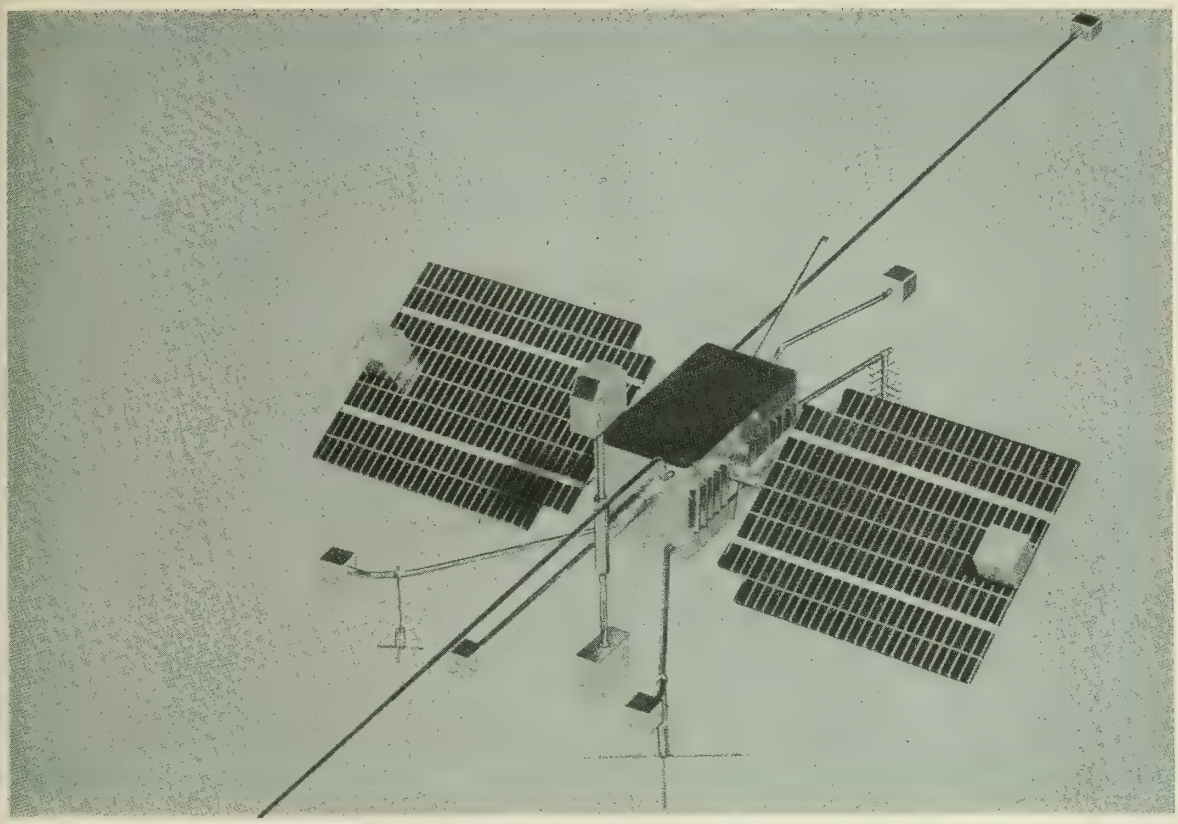
CONFIGURATION: Length—about 30 ft.; Diameter—5 ft.; Weight—approx. 3500 lbs. including complete Agena second stage (capsule payload classified)

INSTRUMENTATION: Infrared detectors—Aerojet-General

SPACE BOOSTER: Atlas-Agena B

PAYLOAD: Infrared detectors to pick up missile launches from characteristics of exhaust gases; data-link telemetry and tape-fed programer

REMARKS: Program has been reoriented because of technical difficulties with IR equipment; orbital system changed from satellite in precise orbits to a system of random satellites; also pushed back to a development program with no date for operational system planned



OGO

Nimbus (NASA)

TYPE: Second-generation weather satellite

MISSION: 650-lb. satellite in 600-mile-high near-polar Earth orbit

STATUS: R&D

PRIME CONTRACTOR: Goddard Space Flight Center. Integration and testing—GE

INSTRUMENTATION: RCA Vidicon cameras for cloud data, radiation sensors at various resolutions and spectral ranges for heat balance, temperature and cloud cover

POWER UNITS: Solar cells and batteries

BOOSTER: Thor-Agena

REMARKS: Four R&D flights 1962-1965. Four operational satellites planned; one 1963, three 1964. More expected

Orbiting Astronomical Observatory (NASA)

TYPE: Unmanned scientific satellite

MISSION: 3500-lb. orbiting satellite to study astronomical phenomena

STATUS: R&D

PRIME CONTRATOR: Grumman

GUIDANCE: GE, stabilization and control; IBM—computer; Kollsman—star trackers

INSTRUMENTATION: Telescope with 36-in. primary mirror, spectrometer

BOOSTER: Atlas-Agena

REMARKS: First flight schedule 1964. Three others scheduled—one 1964, two in 1965. First flight will attempt a detailed map of the sky in ultraviolet light. OAO will be used to develop a standard space observatory

Orbiting Geophysical Observatory (NASA)

TYPE: Large unmanned scientific satellite

MISSION: 1000-lb. satellite with instruments for geophysical measurements, POGO (polar) and EGO (eccentric) shots planned

STATUS: R&D

PRIME CONTRACTOR: Space Technology Laboratories (STL)

PERFORMANCE: Capable of accommodating up to 50 experiments

BOOSTER: Atlas-Agena B and Thor-Agena B

REMARKS: Ten launches scheduled—two in 1963, and 4 each in 1964 and 1965

Orbiting Solar Observatory (NASA)

TYPE: Unmanned scientific satellite

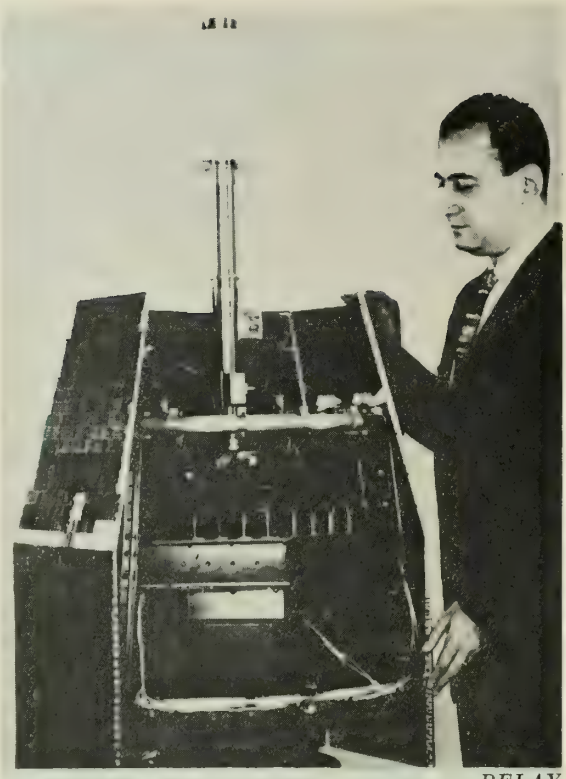
MISSION: 440-lb. orbiting satellite to study solar flare radiation from the Sun

STATUS: R&D

PRIME CONTRACTOR: Ball Brothers

BOOSTER: Thor Delta and Atlas Agena B

REMARKS: First flight March 7, 1962, successful; S-16 early version, S-17 and S-57 advanced versions. Eleven flights scheduled with 3 advanced versions to be launched by the Atlas-Agena B—two, 1962; two, 1963; three, 1964, and four, 1965



RELAY

Relay (NASA)

TYPE: Low-altitude active communication satellite

MISSION: Receive and transmit radio and TV signals by way of the 150-lb. active repeating satellite in a 700-to-3000-mile elliptical orbit

STATUS: R&D

PRIME CONTRACTOR: RCA

INSTRUMENTATION: Duplicate systems for receiving and retransmitting wideband TV, telephone and data signals. Can handle a television transmission or 12 two-way voice channels. Radiation monitoring and radiation damage detectors

POWER UNITS: Solar cells and batteries

BOOSTER: Delta

REMARKS: Britain, France, Brazil and Germany building ground stations; two launchings planned this year, two more in 1963

Rebound (NASA)

TYPE: Passive communications satellite using multiple launching of inflated spheres

MISSION: Reflect radio signal off sphere surface

STATUS: R&D

PRIME CONTRACTOR: None announced

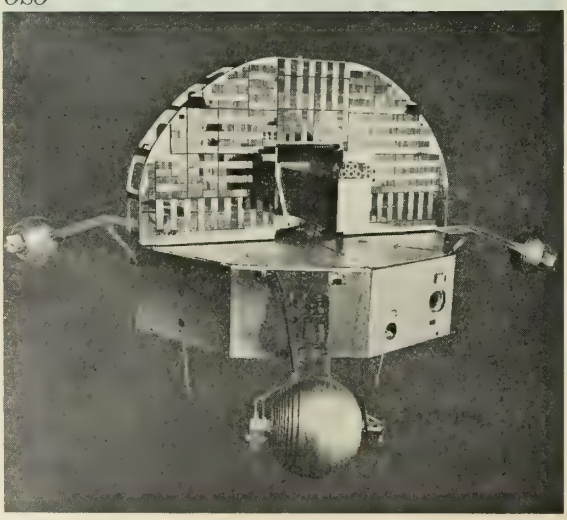
INSTRUMENTATION: None; tracking beacons on sphere

POWER UNITS: Batteries and solar cells

BOOSTER: Atlas-Agena B

REMARKS: System of three rigidized multi-launched low-orbit passive communication satellites; follow-on to Echo. First orbital flight scheduled for 1963. One more scheduled in 1964

OSO



Advanced Relay (NASA)

TYPE: Advanced low-altitude active communications satellite

MISSION: Receive and transmit radio and TV signals by way of 600-lb. spacecraft in a 12,000-mile-high circular orbit.

STATUS: Study

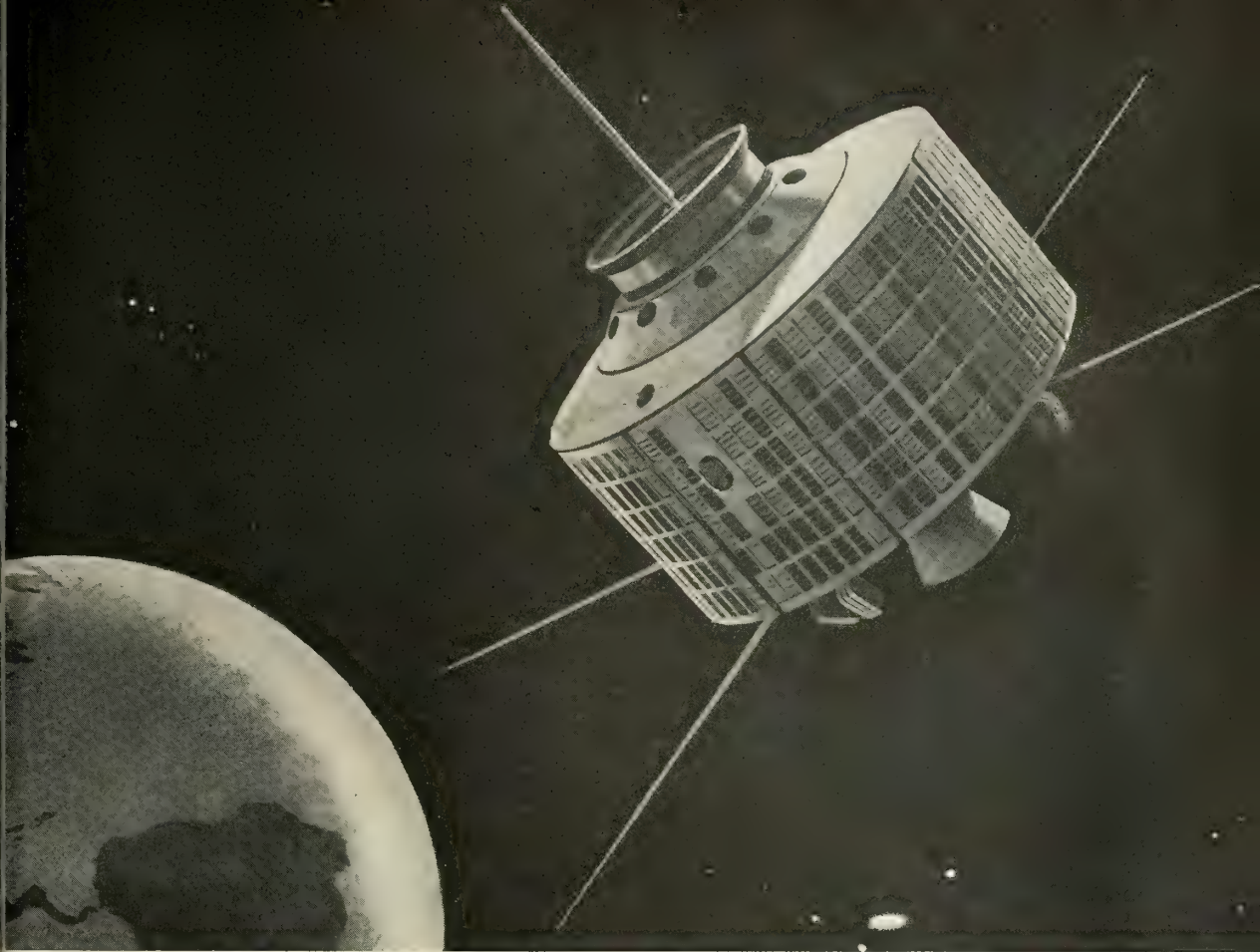
PRIME CONTRACTOR: None selected. Study contract will probably be awarded in the last six months of 1962

INSTRUMENTATION: Not determined

POWER UNITS: Not determined

BOOSTER: Atlas-Agena

REMARKS: Three launches scheduled in 1964. Satellite will be a many-station system and will be available for transmission during 25 per cent of each orbit



SYNCOM

Satellite Inspector (Air Force)

TYPE: Satellite inspection system

STATUS: Development

PRIME CONTRACTOR: RCA

PERFORMANCE: Rendezvous within 50 ft. of unidentified satellite; capable of changing orbit and orbital plane

INSTRUMENTATION: Detection equipment—Hughes Aircraft Co.

SPACE BOOSTER: Atlas-Agena B

PAYLOAD: TV, optical, infrared and radiation detectors

REMARKS: Formerly called SAINT; to rendezvous with and inspect unidentified satellites and relay the data to ground stations; although classified, seems behind schedule since feasibility demonstration was due early this year.

Sert (NASA)

TYPE: Unmanned satellite

MISSION: Spinning satellite for environmental flight tests of two electric engines

STATUS: R&D

PRIME CONTRACTOR: RCA

REMARKS: SERT I will be launched last quarter 1962

Samos (Air Force)

MILITARY DESIGNATION: Part of WS-117

TYPE: Reconnaissance satellite

STATUS: Development

PRIME CONTRACTOR: Lockheed Missile and Space Co.

CONFIGURATION: Length—22 ft.; Diameter—5 ft.; Weight—4100 lbs. (with E-5 capsule), 3000 (with E-6 capsule)

PERFORMANCE: Orbit — circular, 100-300 mile; polar

INTRUMENTATION: Photo intelligence equipment—Eastman Kodak

SPACE BOOSTER: Atlas-Agena B

PAYLOAD: TV and photographic equipment; data telemetry link; Parachute and guidance recovery equipment — Avco and Northrop Ventura; Capsules—General Electric

REMARKS: Highest national priority for reconnaissance system to photograph hostile areas; system will consist of 6-9 satellites; 20-day life for photographic equipment; data is scanned by TV for information of immediate value and then recovered from orbit after useful life, to more effectively evaluate high-resolution photos.

Syncom (NASA)

TYPE: High-altitude active communications satellite

MISSION: Receive and transmit signals by way of 55-lb. satellite in a 22,300-mile-high orbit

STATUS: R&D

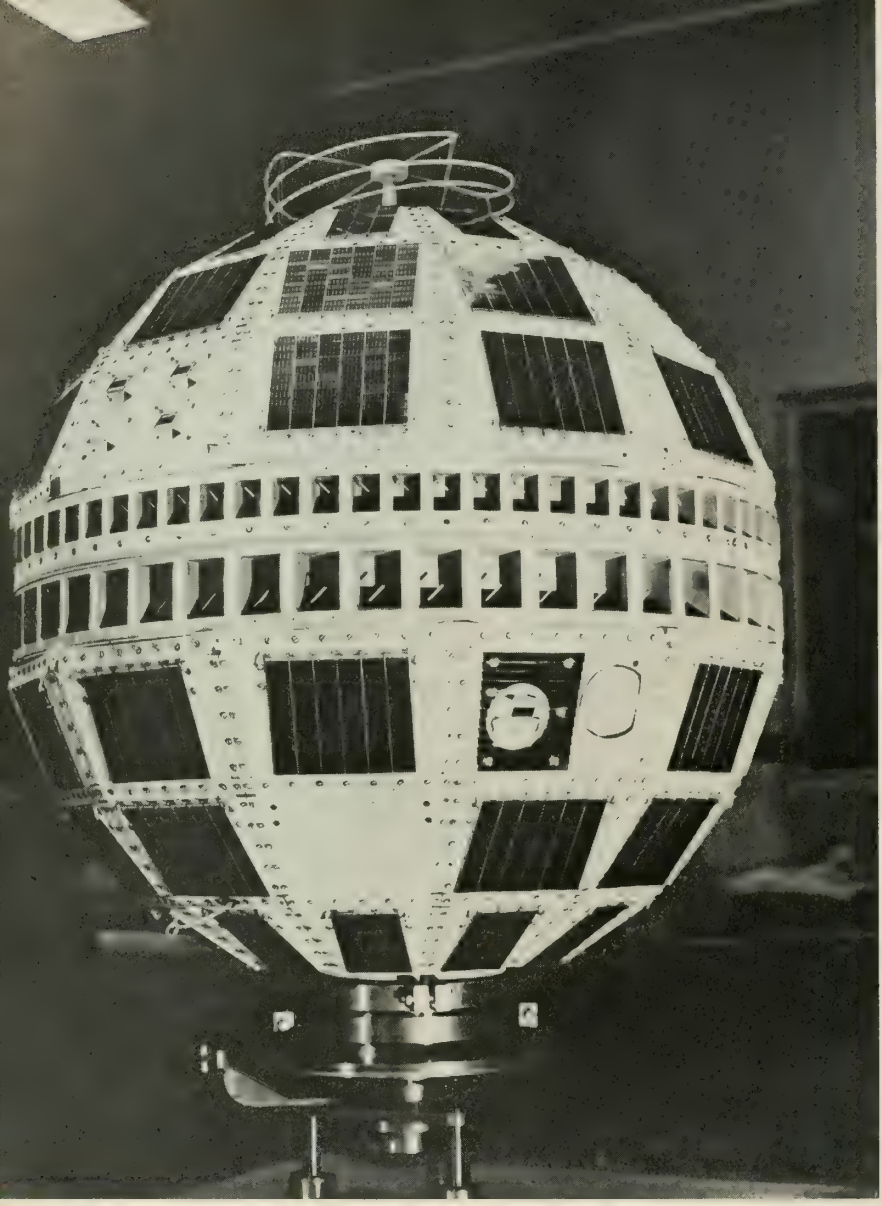
PRIME CONTRACTOR: Hughes

INSTRUMENTATION: Communications antenna, solar sensor, orientation jet, traveling wave tube

POWER UNITS: Solar Cells

BOOSTER: Delta

REMARKS: Three launchings scheduled for Fiscal 1963. Capable of accommodating one full duplex radio telephone channel, initial inclination to be 30 degrees



TELSTAR

Transit (Navy)

TYPE: Navigational satellite

MISSION: Provide a highly accurate navigational satellite system for Naval ships and aircraft under any and all weather conditions

STATUS: Operational late this year

DEPLOYMENT: Four satellites in random, near-circular 600-mile orbit for operational system

PRIME CONTRACTOR: Bureau of Naval Weapons/Applied Physics Lab

BOOSTER: Thor-Able Star

FRAME: Shape—flat-topped drum; Diameter—43 in.; Height—31 in.; Weight—175 lbs.

INSTRUMENTATION: Electronic clock-memory system, magnetic stabilization system, four transmitters, solar cells and nickel-cadmium batteries

AUXILIARY POWER: System Contractor—Martin; Type—SNAP nuclear generator; Power—3 watts; Half-life—90 years

PROPULSION SYSTEM:

REMARKS: First satellite system to use a nuclear-power device; when system is operational in October, it is expected to significantly reduce the position errors of Polaris-firing submarines

Advanced Symcom (NASA)

TYPE: Advanced high-altitude active communications satellite

MISSION: Receive and transmit signals by way of 500-lb. satellite in a 22,300-mile-high orbit

STATUS: Study

PRIME CONTRACTOR: None selected; Hughes, six months study contract

INSTRUMENTATION: Not determined

POWER UNITS: Not determined

BOOSTER: Atlas-Agena

REMARKS: Two launches for 1964, one in 1965. Satellite will have four TV channels and will be launched in an equatorial orbit

Telstar (AT&T)

TYPE: Low-altitude active communications satellite

MISSION: Test broad band microwave communications in space study radiation and micrometeroid effects; test satellite tracking techniques.

STATUS: R&D

PRIME CONTRACTOR: AT&T, launched by NASA on reimbursable basis

ORBIT: Elliptical inclined 45° to equator; 3500 mi. apogee, 600 mi. perigee

CONFIGURATION: Diameter, 34½ in.; weight, 170 lbs.

GUIDANCE: Command Guidance System—Bell Telephone Laboratories

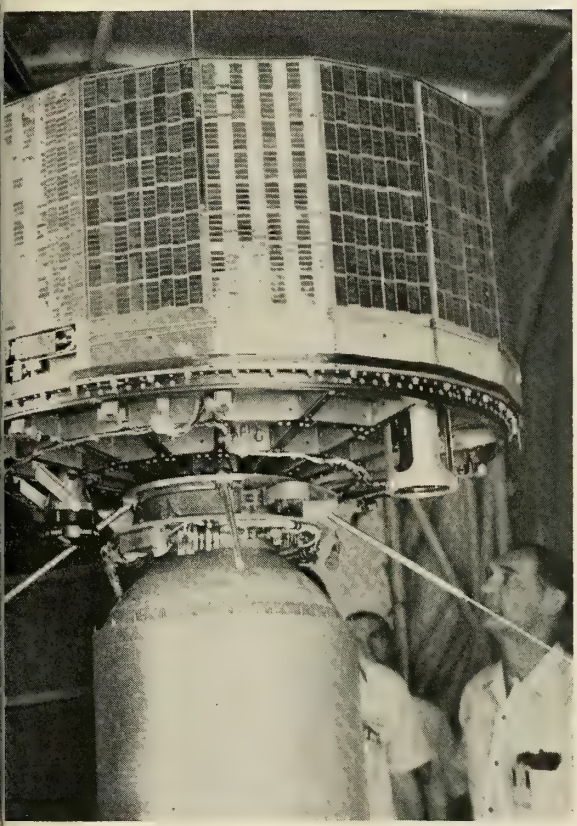
INSTRUMENTATION: Beacons, command receivers, narrow-band PCM-FM-AM telemetry; broad-band communications

FRAME: Magnesium, framework; shell, Aluminum-coated with aluminum oxide

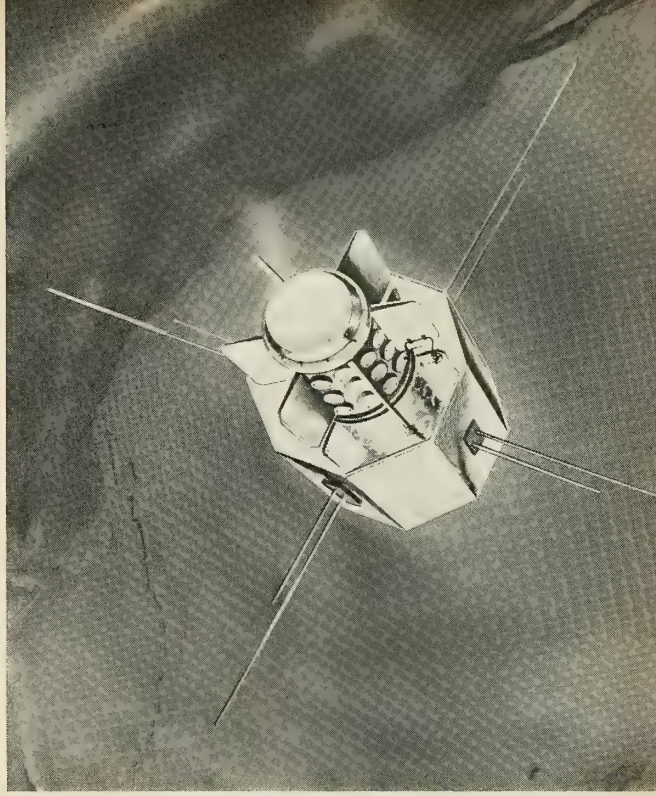
POWER UNITS: Nickel-cadmium batteries and solar cells

BOOSTER: Delta

REMARKS: First launch, July 10, 1962, successful. World's first active communications satellite; successfully received and transmitted TV pictures between America and Europe. Second launch possible in fall, 1962



TIROS 5



TRANSIT

Tiros (NASA)

TYPE: Meteorological Satellite

MISSION: 285-lb. meteorological satellite, TV pictures of cloud cover. Transmits on ground command

STATUS: R&D

PRIME CONTRACTOR: RCA

INSTRUMENTATION: Scanning and non-scanning radiation sensors, narrow- and wide-angle cameras

POWER UNITS: Solar cells and nickel-cadmium storage batteries

BOOSTER: Delta

REMARKS: First launching April, 1960; second Nov. 23, 1960; third, July 12, 1961; fourth, Feb. 8, 1962; fifth, June 19, 1962. All successful. Two more launches planned in 1962

Vela-Hotel (ARPA)

TYPE: Detection system for nuclear explosions in space

STATUS: Development

PRIME CONTRACTOR: Los Alamos Scientific Lab/Aerospace Corp.

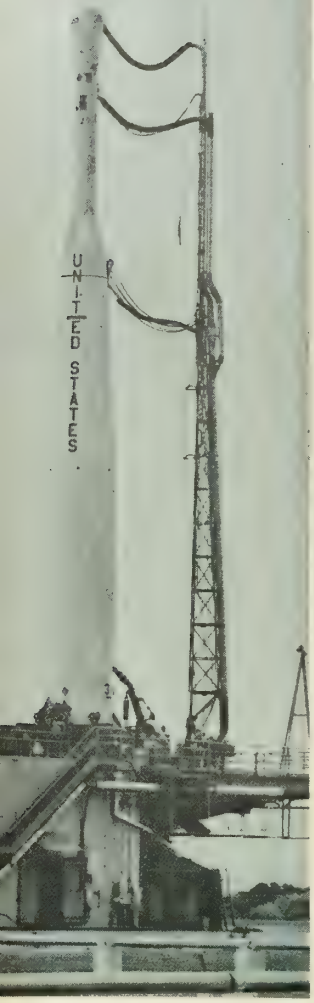
PERFORMANCE: Three satellites in one orbital plane with three more in a plane 90° to the first; Orbital altitude—60,000 n.mi.: Can detect X-rays from nuclear explosion of 1 MT at distance of 3×10^8 km

FRAME: Configuration — 12-sided satellite for optimum coverage; Weight—300-400 lbs. Diameter—40 in.

SPACE BOOSTER: Atlas-Agena B

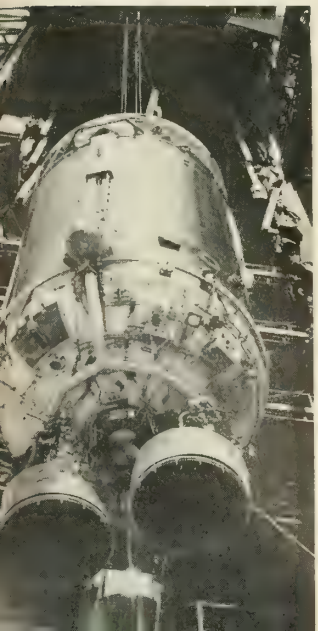
PAYLOAD: X-ray and gamma ray detection equipment and data telemetry links

REMARKS: Initial launchings of payloads expected during this calendar year



DELTA

CENTAUR



Vehicles

Agena B (NASA and Air Force)

TYPE: Upper stage

MISSION: Used as upper stage with Thor and Atlas boosters, in AF Samos, Midas, and Discoverer Programs, NASA's Ranger, Mariner, OAO and other programs

STATUS: R&D

PRIME CONTRACTOR: Lockheed

CONFIGURATION: Weight 1700 lbs. Thor Agena B, 8 ft. diameter, 80 ft. high; Atlas Agena, 10 ft. diameter, 98 ft. high

GUIDANCE: Minneapolis-Honeywell. Type—all-inertial

PROPULSION SYSTEM: All-liquid, Bell IR FNA/UDMH. Thrust— 16,000 lbs.

PAYLOAD: Thor Agena B, 1600 lbs. in 345-mile-high orbit; Atlas Agena, 5000 lbs. in 345-mile-high orbit, 750 lbs. to escape and 400 lbs. in planetary missions

REMARKS: Agena B has restart capability. Agena D is to be developed as standard upper stage with the Titan III. NASA may also use it. NASA has 25 Agena flights planned through 1964

Atlas-Agena B (Air Force)

TYPE: Space booster

STATUS: Operational

PRIME CONTRACTOR: General Dynamics/Astronautics (Atlas); Agena (Lockheed)

PERFORMANCE: Payload — 5000 lbs. in 345-mi. orbit, 750 lbs. to escape, 400 lbs. for planetary missions

FRAME: Length—102 ft.; Diameter (base)—10 ft.; Launch Weight—275,000 lbs.

GUIDANCE: System Contractor—STL Agena B: Minneapolis—Honeywell-inertial reference

PROPULSION SYSTEM: Booster—Rocketdyne (modified Atlas D); Type—Liquid; Thrust—360,000 lbs.; Agena B—Bell Aerospace; Type—Liquid; Thrust—15,000 lbs.; Restart capability

PAYLOAD: Used in Ranger, Discoverer, Midas, Samos and other space programs

REMARKS: Improved, higher-thrust Agena D being developed for future space missions

Blue Scout Jr. (Air Force), HETS

TYPE: Sounding Probe and Small Satellite Launch Vehicle

STATUS: Operational

PRIME CONTRACTOR: Aeronutronic Div., Ford Motor Co.

PERFORMANCE: Payload—150 lbs. (345-mile orbit); 100-lb. probe (1610 mi.); Speed—more than 20,000 fps; Range—over 6000 miles vertical distance; Weight—35,475 lbs.

GUIDANCE: System Contractor—Minneapolis - Honeywell - inertial reference

FRAME: System Contractor—Ling-Temco-Vought; Length — approx. 75 ft.; Diameter—3.3 ft.

PROPULSION SYSTEM: 1st Stage—Aerojet; Type—Solid; Thrust—100,000 lbs.; Name—Algol. 2nd Stage — Thiokol; Type — Solid; Thrust — 55,000 lbs.; Name Castor. 3rd Stage—Hercules; Type—Solid; Thrust — 13,000 lbs.; Name — Antares. 4th Stage—Hercules; Type—Solid; Thrust—3100 lbs.; Name—Altair

PAYLOAD: Scientific instruments and state-of-the-art components and subsystems related to future ballistic missile or space programs

REMARKS: Blue Scout Jr. was designed as a family of special research support vehicles derived from and closely related to NASA's Scout research rocket. Other vehicles in the family, differing only in number or arrangement of stages, are Blue Scout I and II

Centaur (NASA)

TYPE: Multi-purpose upper stage

MISSION: Surveyor and Mariner spacecraft on lunar and interplanetary missions. Will also be used as upper stage for a variety of future space missions

STATUS: R&D

PRIME CONTRACTOR: General Dynamics/Astronautics. Propulsion—Pratt & Whitney

CONFIGURATION: 2 RL-10 engines developing 30,000 lbs. total thrust. Vehicle will have maximum diameter of 10 ft. and with Atlas Booster will be 105 ft. high

GUIDANCE: System contractor—Minneapolis — Honeywell; Type—all-inertial

PROPULSION SYSTEM: RL-10 LOX-liquid hydrogen engine, Pratt & Whitney

PAYLOAD: With Atlas D booster, it will place 8500 lbs. in 345-mile-high altitude, 2300 lbs. to escape velocity and 1300 lbs. on planetary flights

REMARKS: First flight, May 1962, failed when LH_2 tank shielding broke off 54 seconds after launch. Vehicle now 18 months behind schedule. Second launch scheduled for first quarter 1963. Four more launches in 1963 and four more in 1964. Operational target date, 1964

Delta (NASA)

TYPE: Launch vehicle for small payloads

MISSION: Launch vehicle for Tiros, Echo, Explorer, Telstar, and other programs

STATUS: Operational

PRIME CONTRACTOR: Douglas Aircraft Co.

FRAME: Height 90 ft.; Max dia., 8 ft.; lift-off weight, 112,000 lbs.

CONFIGURATION: Three stages

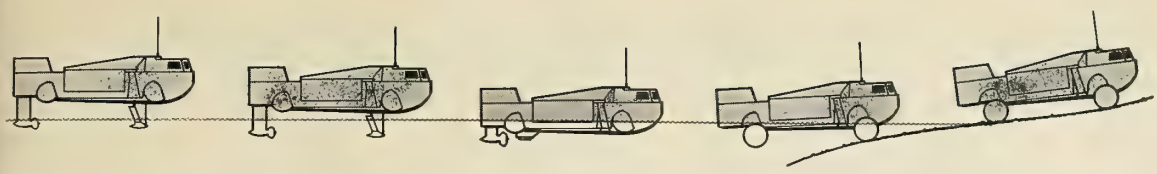
GUIDANCE: Bell Telephone Laboratories

PROPULSION: Liquid-solid: first stage, modified Thor (LOX/RP) (SM-75) thrust 150,000 lbs, Douglas; second AJ10-118, (W1FNA/UDMH) Aerojet-General; thrust 7500 lbs.; Altair, (solid), thrust, 3000 lbs.; Allegany Ballistic Laboratory

PAYLOAD: 500 lbs. in 345-mi. orbit, 60 lbs. to escape

REMARKS: Vehicle has chalked up ten straight successful launches. First order in April, 1959, was for 12 Deltas. NASA now has assigned it to 20 additional missions

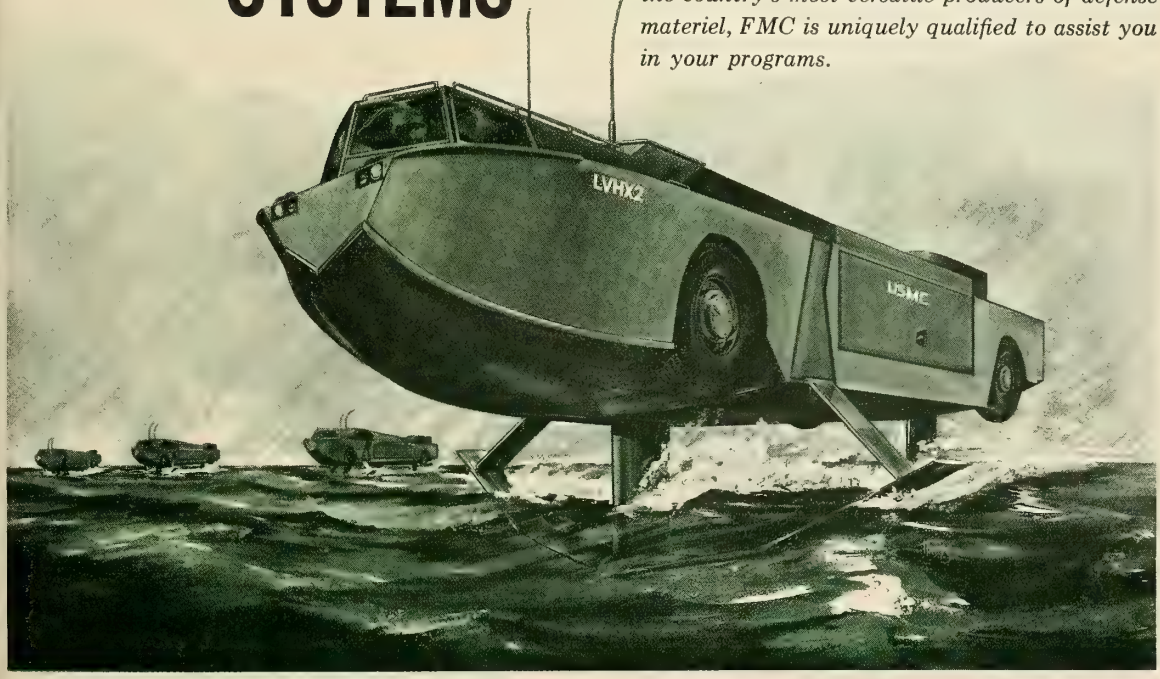
(Continued on page 65)



FMC ADDS "WINGS" TO AMPHIBIOUS RECOVERY SYSTEMS

A new amphibious vehicle, that can "fly" over water on hydrofoils and move inland on retractable wheels, is designed to transport troops and equipment from ship to shore at better than 35 knots. While flying at full speed the foils and propeller can be retracted, and while still underway, the four powered wheels can be lowered to take the vehicle over beaches and cross country terrain and on roads at speeds over 40 mph.

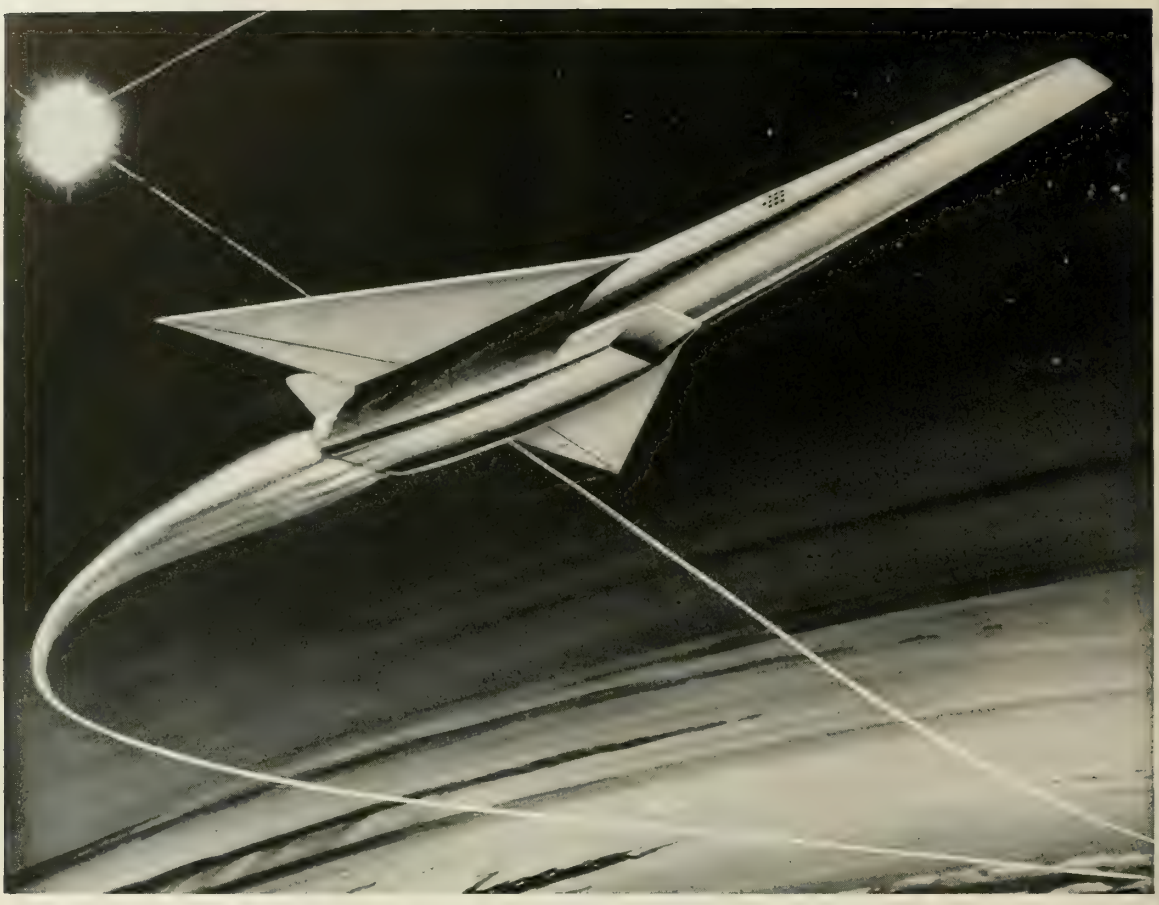
Designated the LVHX2, the swift vehicle is now being developed for the U.S. Marine Corps by FMC's Ordnance Division under a U.S. Navy, Bureau of Ships contract. The LVHX2 is representative of FMC's capabilities in the development of advanced military equipment. *As one of the country's most versatile producers of defense materiel, FMC is uniquely qualified to assist you in your programs.*



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PUTTING IDEAS TO WORK FOR NATIONAL DEFENSE



From sea to stars—the range of LOCKHEED ADVANCED DEVELOPMENT

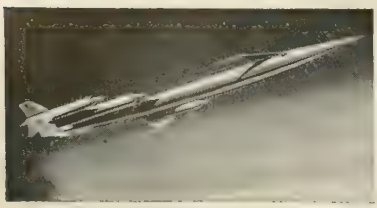
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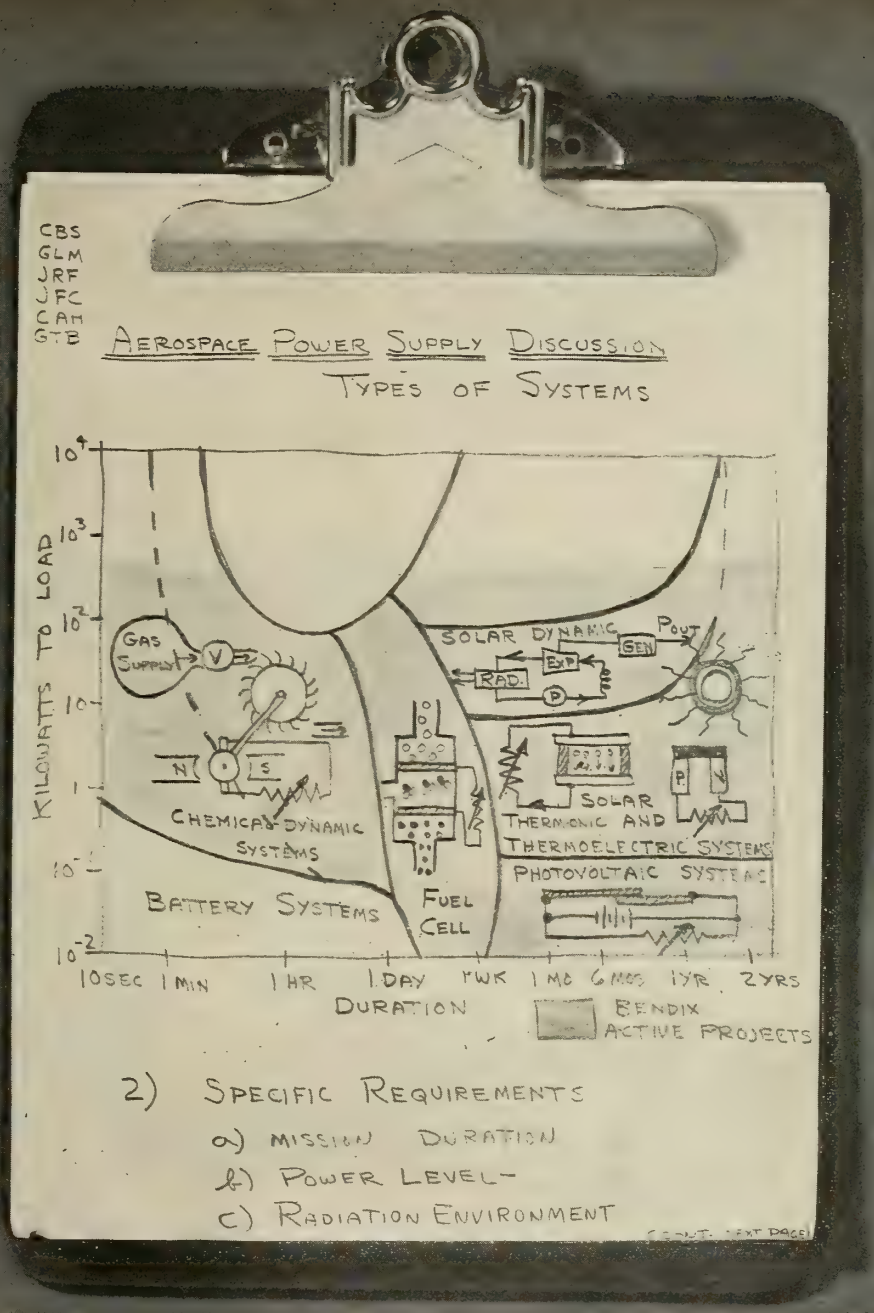
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Aerospace Power Program

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WHERE IDEAS UNLOCK THE FUTURE

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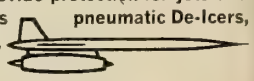
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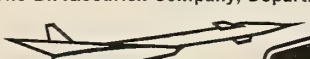




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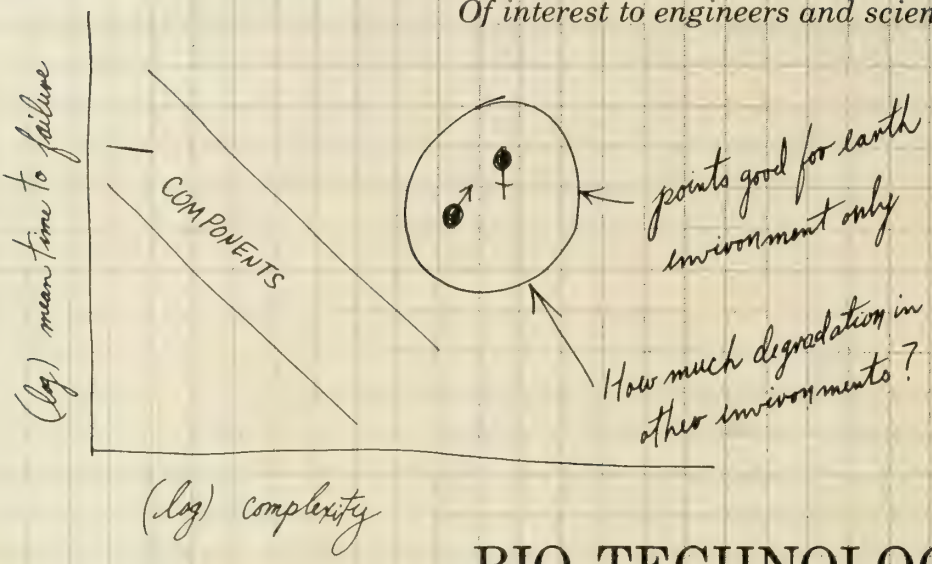
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(Continued from page 56)

Nova (NASA)

TYPE: Multimillion-lb.-thrust launch vehicle

MISSION: Cargo carrier to supply a manned lunar base and booster for manned interplanetary flights

STATUS: Study

PRIME CONTRACTOR: Two firms —General Dynamic/Astronautics, The Martin Co. awarded design study contracts

CONFIGURATION: 50 ft. diameter (could be increased) and 280 ft. high

PROPULSION SYSTEM: All liquid,, first stage, 8 to 12 F-1 engines, Rocketdyne Div. NAA. 2nd stage, two or more M-1 engines, Aerojet-General; third stage one J-2 engine, Rocketdyne Div. NAA

PAYLOAD: 240 to 350 tons in 345-mile orbit; 75 tons escape velocity and 120 tons on planetary flights

REMARKS: Solid first stage may be substituted later. Operational target date 1970

Orion (Air Force)

TYPE: Space propulsion system

STATUS: Feasibility studies

PRIME CONTRACTOR: General Atomics Div., General Dynamics Corp.

PERFORMANCE: Capable of propelling 1000-ton "space platform" by means of small, controlled nuclear explosions

CONFIGURATION: Classified

REMARKS: Program has been under way at General Atomics since July, 1961; Wiesner report to President Kennedy in Jan. '61, recommended that the program be encouraged; however, several key AF officials have complained to Congress that the program is inadequately funded

Rover (NASA and AEC)

TYPE: Nuclear Rocket

MISSION: Superthrust nuclear upper stage to lift heavy payloads on lunar and interplanetary flights

STATUS: R&D

PRIME CONTRACTOR: Lockheed

PROPULSION SYSTEM: Nerva Engine—Aerojet; Westinghouse, subcontractor; reactor to use liquid hydrogen

REMARKS: First Rover flight 1966-67. Operational 1968-69. Will be compatible with both Advanced Saturn and Nova launch vehicles. Reactor for Nerva engine to be selected by the end of the year

Saturn C-1 (NASA)

TYPE: Million-lb.-thrust launch vehicle

MISSION: Boost boilerplate Apollo spacecraft in Earth-orbital flights and launch unmanned planetary spacecraft

STATUS: R&D

PRIME CONTRACTOR: Marshall Space Flight Center. S-1 stage—Chrysler; S-IV stage—Douglas

FRAME: 21.6 ft. wide, 125 ft. high

CONFIGURATION: S-1 stage, 8 H-1 engines developing 1.5 million lbs. thrust, S-IV stage, 6 A3 engines, thrust 90,000 lbs.

PROPULSION SYSTEM: All liquid; H-1 LOX-RP, Rocketdyne Div., NAA; A-3 LOX/H_2, Pratt & Whitney Aircraft

PAYLOAD: 20,000 lbs. in 345-mile orbit

REMARKS: First launch, Oct. 27, 1961; second April 24, 1962, both successful. First flight live upper stage, 1963, to be operational following 10-vehicle flight-test program in late 1964 or early 1965

Saturn C-1B (NASA)

TYPE: Million-lb.-thrust launch vehicle

MISSION: Boost Apollo spacecraft, including lunar landing vehicle, boilerplate models on Earth-orbital flights; also may be used as a supply vehicle

STATUS: R&D

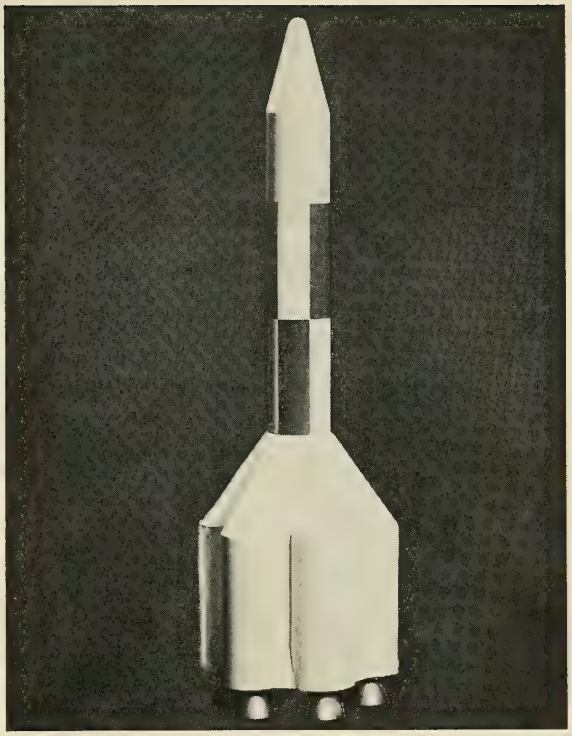
PRIME CONTRACTOR: S-1 stage, Chrysler; S-IVB stage North American

CONFIGURATION: S-1 stage, 8 H-1 engines total thrust 1.5 million lbs.; S-4b stage, 1 J-2 engine 200,000 lbs. thrust

PROPULSION SYSTEM: All liquid; H-1, using LOX/RP, Rocketdyne Div., NAA; J-2, LOX/H_2 Rocketdyne Div., NAA

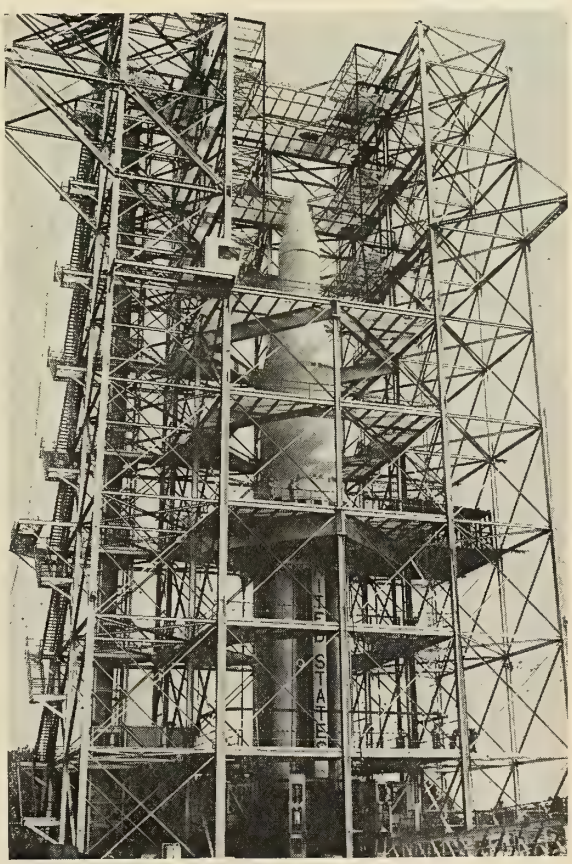
PAYLOAD: 30,000 lbs. in 345-mile Earth orbit

REMARKS: First flight, 1964 or early 1965



NOVA

SATURN C-1



Advanced Saturn (NASA)

TYPE: Multimillion-lb.-thrust launch vehicle

MISSION: Prime booster for the first manned lunar landing mission using the lunar-orbit rendezvous method. Will also boost Orbiting Space Station

STATUS: R&D

PRIME CONTRACTOR: S1B stage, Boeing; S-2 stage, North American; S-4B stage, North American

FRAME: 33 ft. diameter, 275 ft. high

CONFIGURATION: S-1B stage 5 F-1 engines, total thrust 7.5 million lbs.; S-2 Stage 5 J-2 engines, total thrust 1 million lbs.; S-4B stage 1 J-2 engine, total thrust 200,000 lbs.

PROPULSION SYSTEM: All liquid,, F-1 liquid oxygen/kerosene engine, Rocketdyne Div. NAA. J-2 liquid hydrogen/liquid oxygen engine, Rocketdyne Div. NAA

PAYLOAD: 200,000 lbs. in 345-mile Earth orbit; 85,000 lbs. escape; 60,000 lbs. planetary

REMARKS: First flight scheduled for 1965. Engines for 10 vehicles already under contract

Thor-Able Star (Air Force)

TYPE: Medium launch vehicle

STATUS: Operational

PRIME CONTRACTOR: Douglas (Thor); Aerojet (Able Star)

PERFORMANCE: Payload in 300-mile orbit—approx. 900 lbs.

FRAME: Length—79 ft.; Diameter (base) — 8 ft.; Launch Weight — 120,000 lbs.

GUIDANCE: System Contractor—Bell Telephone Labs (both stages)

PROPULSION SYSTEM: Booster—Rocketdyne; Type—Liquid; Thrust—150,000 lbs. Able Star—Aerojet; Type—Hypergolic Liquid; Thrust—7900 lbs.; Restart capability

PAYLOAD: Transit, Composite Anna and Courier satellites use booster

REMARKS: Six successful launches, four failures

Thor-Agena (Air Force and NASA)

TYPE: Launch vehicle

STATUS: R&D with Agena B

PRIME CONTRACTOR: None

PERFORMANCE: Agena B—1600 lbs. in 300-mi. orbit

FRAME: Manufacturers — Douglas, Lockheed. Length overall 86 ft. Diameter — 8 ft. Gross weight Agena B about 123,000 lbs. Major material—aluminum

PROPULSION: All-liquid

GUIDANCE: (Only Agena B) Minneapolis-Honeywell. Type: all-inertial

STAGES: 1-Modified Thor IRBM, Douglas 2. Agena, Engine-Bell XLR-81, Bell Aerospace, Agena Vehicle, Lockheed

REMARKS: Used in Air Force Discoverer program. NASA will use it in Nimbus, Echo, OGO, Topside Sounder satellite and other program. Eleven NASA launches scheduled.

Titan III (Air Force)

MILITARY DESIGNATION: Program 624A

TYPE: Standard space booster

STATUS: Program Definition phase

PRIME CONTRACTOR: Space Systems Div., AFSC/Aerospace Corp.

PERFORMANCE: Payload Capability—5000-20,000 lbs. into low-Earth or synchronous orbits (depending on launch configuration)

GUIDANCE: System Contractor—STL/American Bosch Arma; type—inertial

PROPULSION SYSTEM: Booster—United Technology; Type—120-in. solid (two); Thrust—1,000,000 lbs. each; Weight—500,000 lbs. each; Core Vehicle—Martin (Modified Titan II) Type—Liquid; Thrust—430,-000 lbs.; Restart Capability; Core, 2nd Stage—Aerojet; Type—Liquid; Thrust — 100,000 lbs.; Transition Stage — Aerojet; Type — 2 Liquid engines; Thrust—8000 lbs. each

REMARKS: Titan III still awaiting approval for development from DOD; if approved, program costs will be "in the $1-billion range" with 17 development vehicles—12 Titan II core vehicles and 5 full Titan III's; expected to be standard military launch vehicle for the '60's; X-20 booster

Scout (NASA)

TYPE: Launch vehicle for small payloads

MISSION: Booster for NASA scientific satellites, electric engine, life science and international satellite programs

STATUS: R&D

PRIME CONTRACTOR: Chance Vought

CONFIGURATION: 3.3 ft. maximum diameter, 65 ft. high

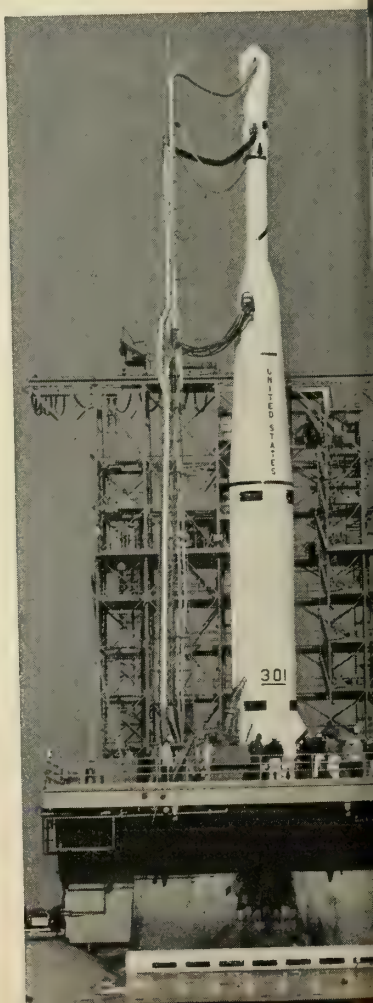
GUIDANCE: Minneapolis-Honeywell. Type—inertial reference

PROPULSION SYSTEM: All solid, 1st stage; Algol, Aerojet-General; 2nd, Castor, Hercules; 3rd, Antares, Thiokol; 4th, Altair, ABL

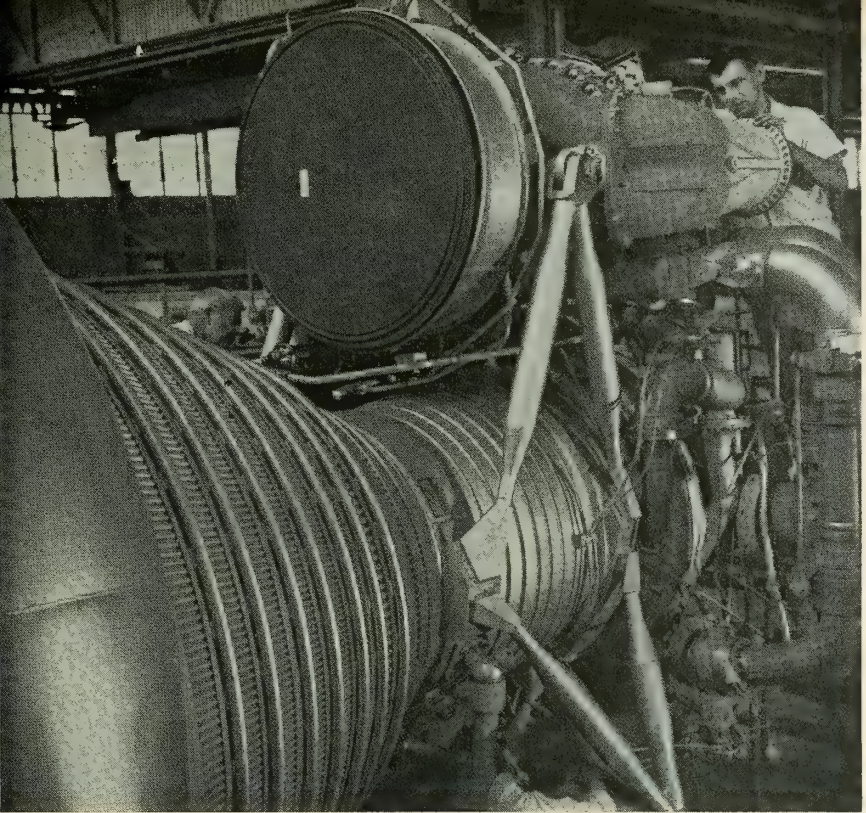
PAYLOAD: Over 200 lbs. in 300-mile orbit

REMARKS: Scout flights in 1961 completed R&D. NASA now has 30 missions assigned to Scout





RIGHT: SCOUT
FAR RIGHT: THOR-DELTA



F-1

Engines

Agena

MANUFACTURER: Bell Aerospace Corp.
MANUFACTURER'S NUMBER: XLP-81-BA-5, -7 and -9
PROPELLANTS: RFNA and UDMH
NOZZLE MATERIAL: uncooled titanium
LENGTH: 7 ft.
WIDTH: 3 ft.
WEIGHT: 300 lbs.
START SYSTEM: solid propellant
IGNITION: hypergolic
PROPELLANT SUPPLY: turbopump, single restart
AVERAGE THRUST: 16,000 lbs.
BURNING TIME: tank capacity
STATUS: Operational—to be used with Ranger, OGO, Nimbus and USAF Agena vehicles

Atlas Booster

MANUFACTURER: Rocketdyne
MANUFACTURER'S NUMBER: MA-2, MA-3 (booster-LR89 NA-5 sustainer, LR105NA)
PROPELLANTS: LOX, RP-1
NOZZLE CONFIG. & EXP. RATIO: Bell, regen. Cooled, 8:1
NOZZLE MATERIAL: nickel
LENGTH: about 8 ft.
WIDTH (MAXIMUM): (one engine) 60 in.
WEIGHT (ONE ENGINE): 1418 lbs.
START SYSTEM: MA-2—LOX-kerosene gas gen.; MA-3—solid propellant
IGNITION: MA-2 — pyrotechnic; MA-3—pyrophoric
PROPELLANT SUPPLY: turbopump —twin pumps operated by single turbine for each chamber
AVERAGE THRUST: MA-2—360,000 lbs. MA-3—389,000 lbs. at sea level
BURNING TIME: 120 sec.
STATUS: Atlas missile, Atlas Agena, Atlas Centaur, Mercury booster

Centaur

MANUFACTURER: Pratt & Whitney
MANUFACTURER'S NUMBER: RL-10
PROPELLANTS: LOX, liquid hydrogen
NOZZLE CONFIG. & EXP. RATIO: mod. bell 40:2
IGNITION: exciter-spark
PROPELLANT SUPPLY: bootstrap-hydrogen gas driven turbopump
AVERAGE THRUST: 15,000 lbs.
SPECIFIC IMPULSE, SEA LEVEL: 30% greater than LOX-Kerosene
BURNING TIME: tank capacity
STATUS: multiple start upper-stage propulsion system—intended for major space missions. First launch due early 1963, four more planned the same year. Four flights planned for its operational year, 1964

F-1

MANUFACTURER: Rocketdyne
MANUFACTURER'S NUMBER: F-1
PROPELLANTS: RP-1, LOX
NOZZLE CONFIG. & EXP. RATIO: mod. bell, regen. cooled, more than 12:1
LENGTH: About 20 ft.
WIDTH: About 12 ft.
WEIGHT: About 20,000 lbs.
START SYSTEM: Solid propellant
IGNITION: Pyrophoric
PROPELLANT SUPPLY: Turbopump
AVERAGE THRUST: 1.5 million lbs.
SPECIFIC IMPULSE, SEA LEVEL: about 260 sec.
BURNING TIME: Tank capacity
STATUS: Originally intended for Nova; now slated for Advanced Saturn in a cluster of 5 engines

J-2

MANUFACTURER: Rocketdyne
MANUFACTERER'S NUMBER: J-2
PROPELLANTS: LOX; liquid hydrogen
AVERAGE THRUST: 200,000 lbs.
SPECIFIC IMPULSE, SEA LEVEL: not released
BURNING TIME: tank capacity
STATUS: Slated for Advanced Saturn C-5 upper stages

Nerva

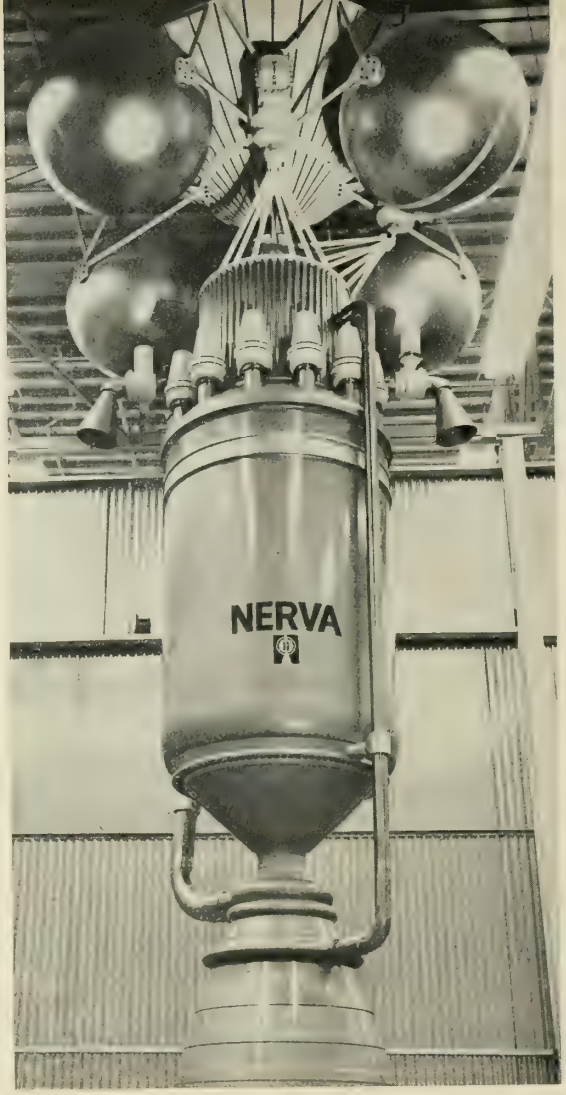
MANUFACTURER: Aerojet-General
MANUFACTURER'S NUMBER: NERVA
PROPELLANTS: Gaseous hydrogen
NOZZLE CONFIG. & EXP. RATIO: regen. cooled
IGNITION: passing liquid hydrogen through the nuclear reactor superheats the propellant which is then expended through the nozzle
PROPELLANT SUPPLY: turbopump
SPECIFIC IMPULSE, SEA LEVEL: should be in the 800-sec. area
STATUS: development with tests scheduled for 1966-67 period. NERVA engine will be on a RIFT (Reactor In Flight Test) vehicle. Reactor under contract to Westinghouse, RIFT being built by Lockheed

Saturn C-1

MANUFACTURER: Rocketdyne, Div. North American Aviation
MANUFACTURER'S NUMBER: H-1
PROPELLANTS: LOX, Kerosene
NOZZLE CONFIG. & EXP. RATIO: bell, regen. cooled, 8:1
NOZZLE MATERIAL: nickel
LENGTH: About 8 ft.
WIDTH (MAXIMUM): 60 in.
WEIGHT: About 1400 lbs.
START SYSTEM: Solid Propellant
IGNITION: Pyrophoric
PROPELLANT SUPPLY: Turbopumped
AVERAGE THRUST: 188,000 lbs.
SPECIFIC IMPULSE, SEA LEVEL: 255 sec.
BURNING TIME: Tank capacity
STATUS: Cluster of 8 for Saturn C-1

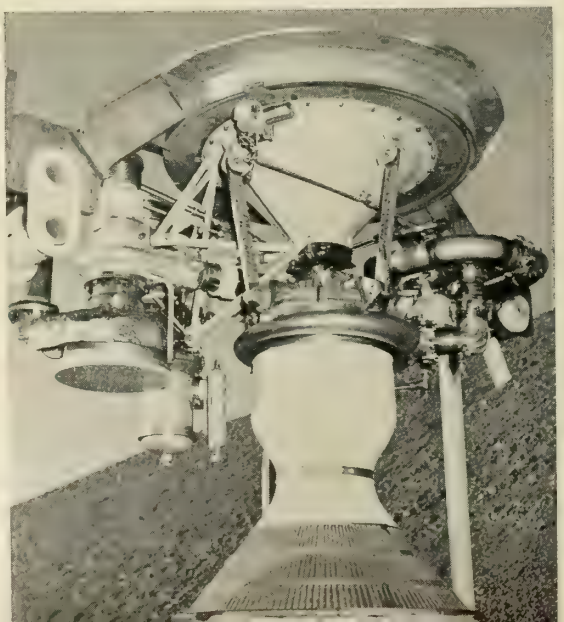
Thor Propulsion System

MANUFACTURER: Rocketdyne
MANUFACTURER'S NUMBER. MB-3 (XLR70NA-9) operational missiles. MB-3 (XLR70NA-11) space programs
PROPELLANTS: RP-1 or RJ-1 and LOX
PROPELLANT SUPPLY: twin pumps driven by single turbine
AVERAGE THRUST: NA-9 150,000 lbs. NA-11 165,000 lbs.
BURNING TIME: tank capacity



NERVA

TITAN II—SECOND STAGE



Second Stage Delta Propulsion

MANUFACTURER: Aerojet-General
MANUFACTURER'S NUMBER: AJ10-118
PROPELLANTS: IRFNA and UDMH
LENGTH: 190 in.
WIDTH (MAXIMUM): 32 in.
WEIGHT: 645 lbs.
IGNITION: hypergolic
PROPELLANT SUPPLY: pneumatically pressurized tanks
AVERAGE THRUST: 7500 lbs.
BURNING TIME: tank capacity
STATUS: Thor-Delta scientific satellite launch vehicle

Titan I Booster

MANUFACTURER: Aerojet-General
MANUFACTURER'S NUMBER: LR-87-AJ-3
PROPELLANTS: LOX, kerosene
NOZZLE CONFIG. & EXP. RATIO: bell, regen. cooled 8:1
NOZZLE MATERIAL: nickel
LENGTH: about 10 ft.
WIDTH (MAXIMUM): about 9 ft.
WEIGHT: about 3700 lbs.
START SYSTEM. ground-supplied
IGNITION: pyrotechnic
PROPELLANT SUPPLY: turbopumped
AVERAGE THRUST: 30,000 lbs.
BURNING TIME: 120 sec.

Titan II— First Stage

MANUFACTURER: Aerojet-General
MANUFACTURER'S NUMBER: LR-87-AJ-5
PROPELLANTS: nitrogen tetroxide, Aerozene-50
NOZZLE CONFIG. & EXP. RATIO: bell, regen. cooled, 8:1
START SYSTEM: bootstrap
IGNITION: hypergolic
PROPELLANT SUPPLY: turbopump
AVERAGE THRUST: 430,000 lbs.
BURNING TIME: tank capacity

Titan II— Second Stage

MANUFACTURER: Aerojet-General
PROPELLANTS: nitrogen tetroxide, Aerozene-50
NOZZLE CONFIG. & EXP. RATIO: mod. bell, regen. cooled, 45:1
START SYSTEM: bootstrap
IGNITION: hypergolic
PROPELLANT SUPPLY: turbopump
BURNING TIME: tank capacity

SOUNDING ROCKETS

(Listed under contractor: stages; weight [lbs.]; height [ft.]; performance; and remarks)

Space-General Corp.

AEROBEE 100 (AEROBEE, JR.) one liquid (IRFNA & JP-4) engine—2600-lb.-thrust for 40 sec., solid booster—Aerojet 2.5KS-18,000; 1400 lbs.; 25.75; 70 lbs. to an altitude of 80 mi. Max. acceleration 15.2 g; standard NASA/AF vehicle; tower-launched.

150 & 150A (AEROBEE-HI) one liquid (IRFNA & aniline-furfuryl alcohol mixture)-4100-lb.-thrust for 51.8 sec., solid booster—Aerojet 2.5KS-18,000; 1943 lbs., 29.67 (150)—1941 lbs., 30.00 (150A); 150 lbs. to an altitude of 152 mi. Max. acceleration 10.3 g; standard NASA/AF/Navy vehicle; tower-launched; 150A has 4 fins and improved aerodynamic characteristics.

300 & 300A (SPAEROBEE) 1st—Aerobee 100 system, 2nd—solid rocket (Aerojet, Sparrow 1.8KS-7800), Booster—Aerojet 2.5KS-18,000; 2103 lbs. 33.0 (300) 33.3 (300A); 50 lbs. to an altitude of 300 mi. Max. acceleration 63.8 g; standard NASA/AF vehicle; 300A has 4 fins; performance similar to 300.

350 not available; 150 lbs. to an altitude of 350 mi. design goal; under development for NASA; 5 to be procured during '63.

ASTROBEE-200 solid sustainer-Aerojet 30 KS-8000, Booster-Nike solid motor; 2601 lbs.; 26.42; 165 lbs. to an altitude of 182 mi. Max. acceleration 18.9 g; NASA/AF/Navy vehicle; boom-launched.

250-1 solid sustainer-Aerojet Junior (28KS-57,000), Booster—two Thiokol Recruit solid motors (1.52KS-33,500); 10,358 lbs.; 34.17; can carry payloads from 600-1300 lbs. to altitudes between 200-250 mi. Max. acceleration 13 g; NASA/AF/Navy vehicle; min. 600-lb. payload required for stability; boom-launched.

1500 1st-Solid Aerojet Aerobee Jr. rocket, 2nd-Solid Aerojet 30KS-8000 (AJ10-41) rocket. Booster—two Thiokol solid Recruit rockets (1.5KS-35,000); 11,493 lbs.; 34.17; 130 lbs. to an altitude of 1300 mi. Max. acceleration 37.2 g; NASA/AF/Navy vehicle boom-launched; under development.

Aerolab Development Co.

ARGO A-1 one Thiokol TX-33 solid motor with two solid Recruit rockets (150,000 lbs. thrust); 10,335 lbs.; 21.25; 500-lb. payload to altitude of 220 mi.; NASA; used in suborbital test of Echo balloon.

ARGO B-1 1st—Hercules/ABL solid motor (50,000-lb.-thrust), 2nd—Thiokol Cajun 2.8KS-8100; 1540 lbs.; 23.0; 50-lb. payload to 110 mile altitude; max. acceleration 52 g; NASA/AF; also known as Nike-Cajun.

ARGO D-4 (JAVELIN) 1st—Honest John-86,000-lb.-thrust, 2nd-Nike—48,700-lb. thrust, 3rd-Nike—48,700-lb.-thrust, 4th-X248 Altair Motor—3150-lb.-thrust; 7300 lbs.; 49.0; D-4: 50 lbs. to an altitude of 700 mi. Javelin: ceiling of 1000 mi.; D-4: NASA designation; Javelin: AF.

ARGO D-8 (JOURNEYMAN) 1st—Thiokol XM-33 motor, 2nd—Alleghany X-254 motor*, 3rd—Aerojet 30KS-8000 motor*, 4th—X248 Altair motor, *D-8 uses Lockheed, 47,000-lb.-thrust Lance motors; 14,000 lbs.; 62.0; D-8: 130 lbs. to an altitude of 1200 mi. Journeyman: Ceiling 25,000-30,000 mi.; D-8; NASA Journeyman: AF used to measure radiation around Earth (NERV).

ARGO E-5 (JASON) 1st Honest John motor, 2nd—Nike motor, 3rd—Nike motor, 4th—Thiokol Recruit, TX-77 motor, 5th—Thiokol T-55 motor; 7250 lbs.; 57.5; 50 lb. payload to altitude of 500 mi.; E-5: NASA Jason: AF used in Project Argus nuclear tests.

TRAILBLAZER I 1st—Honest John Motor, 2nd—Nike motor, 3rd—Lance motor, 4th—Thiokol T-40 motor, 5th—Thiokol T-55 motor, 6th—Langley 5" spherical motor; —; 56; first three stages carry vehicle to 200 mi. last three fire payload back into atmosphere at speeds up to 25,000 ft./sec.; NASA high-speed re-entry test vehicle.

Atlantic Research Corp.

ARCAS one solid 350-lb.-thrust ARCAS motor; 65 lbs.; 6.6 to 9.1; 10-lb. payload to altitude of 50 mi.; all services & NASA use vehicle.

BOOSTED ARCAS same 1st Stage as ARCAS Booster—ARC IKS 2200 solid motor; 110 lbs.; 9.7 to 12.2; 10-lb. payload to altitude of 70 mi.; all services & NASA use vehicle.

ARCHER single solid motor with 1375 lbs. thrust; 330 lbs.; 12.8; 40-lb. payload to altitude of 90 mi.; all services & NASA use vehicle.

IRIS single solid motor with 4000 lbs. thrust; 1350 lbs.; 24; 100-lb. payload to altitude of 200 mi.; all services & NASA use vehicle.

IRIS II 1st—4000-lb.-thrust IRIS motor, 2nd—ARC solid spherical motor; 1380 lbs.; 23; 20-lb. payload to altitude of 650 mi.; all services & NASA use vehicle.

METROC single solid motor with 130 lbs. thrust; 15 lbs.; 4.6; 2-lb. payload to altitude of 20 mi.; all services & NASA use vehicle.

BOOSTED METROC same 1st stage as METROC Booster—Navy 2.75 FFAR solid motor with 720 lbs. thrust; 26 lbs.; 8.8; 2-lb. payload to altitude of 52 mi.; all services & NASA use vehicle.

NIKE-ARCHER 1st—Archer solid motor, Booster-Nike 59,000-lb.-thrust solid motor; 1650 lbs.; 25; 40-lb. payload to altitude of 230 mi.; all services & NASA use vehicle.

TRAILBLAZER II 1st—Thiokol Castor solid motor (53,850 lbs. thrust), 2nd—Lance solid motor (50,000 lbs. thrust), 3rd—ABL X-248 Altair solid motor (3100 lbs. thrust), 4th—ARC-NASA 15 in. solid spherical motor; 13,344 lbs.; 50; 1st two stages: 20-lb. payload to altitude of 200 mi. Last two stages: Fire downward to get payload up to re-entry velocity of 22,000 fps.; high speed re-entry test vehicle to be used by NASA, AF and Army.

Douglas Aircraft Co.

ROCKAIRE single DM-16 JATO unit with 7800 lbs. thrust; 181 lbs.; 8.9; 40-lb. payload to altitude of about 200 mi.; AF; rocket air-launched.

Hercules Powder Co.

DEACON single solid motor with thrust of 6400 lbs. for 3.2 sec.; 200 lbs.; 9.7; varies with program; NASA/Army/Navy & ARPA use vehicle in various programs.

EXOS 1st—Honest John solid motor, 2nd—Nike solid motor, 3rd—Recruit solid motor; 5400 lbs.; 38.0; 80-lb. payload to altitude of 300 mi.; AF vehicle; designed and assembled by U. of Michigan.

Lockheed Propulsion Co.

VIPER I-C, II-B & II-C single 5.60-KS-5400 (I-C) or 3.77-KS-8040 (II-B&C) solid rocket motor; 200.1 lbs.; 8.9; (I & II-C)—191.2; 8.9: (II-B) not given; built for sled testing, AF, Sandia and Martin have used as sounding rockets.

The Marquardt Corp.

ASP I single 5.3-KS-5800 solid motor; 216.5 lbs.; 8.9; 50-lb. payload to altitude of 35 mi. Max. acceleration 58 g; Navy.

ASP IV single 12.7-KS-2750 solid motor; 208 lbs.; 8.9; 50 lb. payload to an altitude of 50 mi. Max. acceleration 20 g; Navy.

ASPAN 150 1st—ASP I solid motor, Booster—Nike solid motor; 1503.0 lbs.; 21; 50 lb. payload to an altitude of 150 mi. Max. acceleration 53 g; AF, NASA also used vehicle but is phasing it out.

ASPAN 300 1st—ASP IV solid motor, Booster—Nike solid motor; 1491.5 lbs.; 21; 50 lbs. to 200 mi. also capable of carrying payloads to altitudes from 225-425 mi. Max. acceleration for 60 lb. payload 41 g; Navy.

BOA 1st—Honest John solid motor, 2nd—Nike solid motor, 3rd—Nike solid motor; 6666 lbs.; 38.8; designed to carry a 500 lb. payload to an altitude of 75 mi. Max. acceleration 45 g; AF.

KING COBRA 1st—Honest John solid motor, 2nd—Nike solid motor, 3rd—Nike solid motor, 4th—Asp 1; 6882 lbs.; 47.75; designed to carry 100-lb. payload to altitude of 300 mi. or a 25-lb. payload to 500 mi. Max. acceleration 51 g; launched from standard zero-length launcher.

QUEEN COBRA 1st—Honest John solid motor, 2nd—Nike solid motor, 3rd—Nike solid motor, 4th—Cluster of 5 Cooper/Marquardt solid motors identical to upper stage Explorer cluster; 7146 lbs.; 44.18; designed to carry large-diameter payloads to altitude of 200 mi. or 800-lb. payload to 75 mi.; max. acceleration 30 g; launched from standard zero-length launcher.

PYTHON 1st—Nike solid motor, 2nd—Nike solid motor; 5566 lbs.; 22.5; designed to carry 400-lb. payload to altitude of 25 mi. Max. acceleration 40 g; AF.

ROKSONDE 100 single solid motor; 17.9 lbs.; 5.3; designed to carry a meteorological payload to altitudes of 125,000 ft. Max. acceleration 199 g; payload is a separate free-flight, low-drag dart with desired instrumentation.

ROKSONDE 200 single, 2000-lb.-thrust solid motor; 22.5 lbs.; 5.3; designed to lift 71-lb. payload to an altitude of over 200,000 ft. Max. acceleration 137 g; payload similar to 100; AF/Army use vehicle.

STARSEEKER 1st—Modified Aerojet Junior solid motor with 4 Aerojet assist booster motors, 2nd—11 clustered Cooper/Marquardt Scamp solid motors, 3rd—3 clustered Scamp motors, 4th—1 Scamp motor; 13,300 lbs.; 36.0; designed to carry 100-lb. payload to altitude of 1,000 mi. or 20-lb. payload to 2000 mi. Max. acceleration 45 g; Three-stage version: Starseeker I.

Rocketdyne Div., North American Aviation, Inc.

AEOLUS I; I-90 single 315-lb.-thrust solid motor; 41 lbs.; 4.25; I can carry a 6-lb. payload to altitude of 230,000 ft.; I-90, a 6-lb. payload to 90,000 ft.; Navy; fired from 5 in. gun or its reinforced plastic shipping container.

AEOLUS I-200 single 500-lb.-thrust solid motor; 69.6 lbs.; 7.39; designed to carry 6-8-lb. payload to over 200,000 ft.; Navy.

Rocket Power, Inc.

PHOENIX 1st—high-acceleration Kiva solid motor, 2nd—Hopi solid motor; 300 lbs.; 1.8; 10-lb. payload to altitude of 200 mi. Max. acceleration 131 g; Rail-launched. Fired in Aug. '60 from PMR.

Several Manufacturers

NIKE-APACHE 1st—Nike solid motor, 2nd—Apache solid motor (improved version of Thiokol Cajun motor); 1480 lbs.; 21; 50-lb. payload to altitude of 150 mi.; NASA to fire total of 10 this year.

NIKE-CAJUN 1st—Nike solid motor, 2nd—Thiokol, 2.8-KS-8100, Cajun solid motor; 1350 lbs.; 22; 50-lb. payload to altitude of 110 mi.; NASA to fire total of 45 this year.

SATELLITES IN ORBIT

(Name and country; weight (lbs.); launch vehicle; launch date; purpose: remarks)

EXPLORER I, U.S. 30.8 lbs.; JUPITER C; 1/31/58; 1698/359; radiation measurements; discovered Van Allen belt.

VANGUARD I, U.S. 3.25 lbs.; VANGUARD; 3/17/58; 3949/639; micrometeor impact & geodetic data; still transmitting—108.024 mc.

VANGUARD II, U.S. 20.7 lbs.; VANGUARD; 2/17/59; 3292/551; measurement of sunlight reflected from cloud cover; interpretation of data difficult due to precessing of vehicle.

LUNIK I, USSR 3245 lbs.; unknown; 1/2/59; 1.315AU/0.9766AU; studied gas, magnetic fields and particles in space; in orbit around the Sun on 450-day period.

PIONEER IV, U.S. 13.4 lbs.; JUNO II; 3/3/59; 1.142AU/0.9871AU; radiation measurements; in orbit around the Sun on 398-day period.

VANGUARD III, U.S. 100 lbs.; VANGUARD; 9/18/59; 3743/493; magnetic field measurements; ended Vanguard program.

EXPLORER VII, U.S. 91.5 lbs.; JUNO II; 10/13/59; 1071/557; micrometeorite impacts; Earth's radiation measurements; est. life 30-40 years.

PIONEER V, U.S. 94.8 lbs.; THOR-ABLE; 3/11/60; .995AU/.8061AU; to investigate space between Earth and Venus; 1st radio communication at interplanetary distances (22 million miles).

TIROS I, U.S. 270 lbs.; THOR-ABLE; 4/1/60; 745/696; to test TV techniques for weather satellites; transmitted 22,952 cloud cover photos in 78-day lifetime.

TRANSIT IB, U.S. 265 lbs.; THOR-ABLE STAR; 4/12/60; 633/362; to develop basis for navigational satellite system; Able Star achieved first known restart in space.

SPUTNIK IV, USSR 10,008 lbs.; unknown; 5/15/60; 312/238; to test life support for manned vehicle & re-entry of cabin from orbit; on May 19 command was sent to re-enter cabin; satellite either exploded or separated into pieces; no recovery.

MIDAS II, U.S. 5000 lbs.; ATLAS-AGENA A; 5/24/60; 500/476; to gather data on operation of IR-sensing system; to test system techniques & components; achieved objectives, but two days after launch telemetry link failed.

TRANSIT IIA, U.S. 223 lbs.; THOR-ABLE STAR; 6/22/60; 1057/613; to demonstrate equipment for navigational satellite system; still transmitting 162; 216 mc.

NRL SOLAR RADIATION SATELLITE, U.S. 40 lbs.; THOR-ABLE STAR; 6/22/60; 1057/612; solar activity measurement; carried into orbit "piggyback" on Transit IIA.

ECHO I, U.S. 142 lbs.; THOR-DELTA; 8/12/60; 1763/1246; to test feasibility of passive communications satellites; badly wrinkled from particle impacts.

COURIER 1B, U.S. 500 lbs.; THOR-ABLE STAR; 10/4/60; 1217/962; to test the feasibility of delayed repeater communications satellites for military use; test objectives met; still transmitting 107.684 mc.

EXPLORER VIII, U.S. 90 lbs.; JUNO II; 11/3/60; 2260/421; investigation of the ionosphere; data to be used to improve communications

TIROS II, U.S. 280 lbs.; THOR-DELTA; 11/23/60; 725/625; to test TV, IR and new attitude-control systems for weather satellites; est. life 200-500 yrs.

SAMOS II, U.S. 4100 lbs.; ATLAS-AGENA A; 1/31/61; 547/470; to test feasibility of Earth observations from satellites; 1st successful flight of reconnaissance satellite.

VENUS PROBE, USSR 1419 lbs.; unknown; 1/12/61; 1.0190AU/0.7183AU; cosmic ray, magnetic field, charged particle and micrometeorite measurements; Sputnik VIII was also launched on same booster. Radio contact with probe lost 2/27/61.

EXPLORER IX, U.S. 15 lbs.; SCOUT; 1/17/61; 2439/743; measure drag on 12-ft. sphere in space; 1st satellite placed in orbit by an all-solid rocket.

DISCOVERER XX, U.S. 2450 lbs. THOR-AGENA B; 2/17/61; 330/238; evaluation of Agena B, particularly stabilization system; malfunction prevented attempt to recover capsule.

EXPLORER X, U.S. 79 lbs.; THOR-DELTA; 3/25/61; position uncertain; data on magnetic fields and effect on and by solar plasma; transmitted "fantastically clean" data for 60 hours.

EXPLORER XI, U.S. 82 lbs.; JUNO II; 4/27/61; 1763/506; to detect high-energy gamma rays from cosmic sources and map their distribution; 1st Astronomical Observatory satellite.

TRANSIT IVA, U.S. 175 lbs., THOR-ABLE STAR; 6/29/61; 1005/873; continuing development of satellite navigation system; still transmitting: 54; 150; 324; 400 mc; 1st nuclear device in orbit (SNAP); proof of Earth's ellipticity.

INJUN-SR-3, U.S. 95 lbs.; THOR-ABLE STAR; 6/29/61; 1003/876; Injun: Measure Van Allen belt cosmic ray intensity. Greb III: solar X-ray measurement; Injun and Greb carried "piggy-back" on Transit IVA; failed to separate; experiments functioned, however.

TIROS III, U.S. 285 lbs.; THOR-DELTA; 7/12/61; 821/735 meteorological data including cloud cover photos and IR measurements; photographed many tropical storms during '61 hurricane season; discovered hurricane Esther.

MIDAS III, U.S. 3500 lbs.; ATLAS-AGENA B; 7/12/61; 3534/3356; put spacecraft in near circular orbit and gather data on detection capabilities; weighed considerably less than previous MIDAS vehicles. 1st to be put in polar orbit.

EXPLORER XII, U.S. 83 lbs.; THOR-DELTA; 8/15/61; insufficient observations; investigate solar winds, interplanetary magnetic fields, Earth magnetic fields and energetic particles; 1st of four satellites to achieve these objectives; discovered proton, rather than electron makeup of outer Van Allen belt.

MIDAS IV, U.S. 3500 lbs.; ATLAS-AGENA B; 10/21/61; 3750/3502; Same as MIDAS III; carried West-Ford needles experiment which failed to disperse.

DISCOVERER XXXIV, U.S. 2100 lbs.; THOR-AGENA B; 11/5/61; 707/223; experimental data for follow-on space programs; malfunction prevented recovery of capsule.

TRANSIT IV-B, U.S. 175 lbs.; THOR-ABLE STAR; 11/15/61; 1120/943; same as Transit IVA; operational prototype of Navy navigational satellite system; transmitting.

TRAAC 65 lbs.; THOR-ABLE STAR; 11/15/61; 1100/950; test feasibility of spacecraft stabilization using Earth's gravitational field; 1st spacecraft to utilize this means of stabilization; "piggy-back" on Transit IV-B.

NONE, U.S. not given; ATLAS-AGENA B; 12/22/61; 458/212; not released; presumably Discoverer-type vehicle.

RANGER III, U.S. 727 lbs.; ATLAS-AGENA B; 1/26/62; 1.163AU/0.9839AU; Lunar impact and rough land instrumented capsule on the Moon; failed to accomplish its mission; orbit around the Sun on 406.4 day period.

TIROS IV, U.S. 285 lbs.; THOR-DELTA; 2/8/62; 839/714; gather cloud cover pictures and IR heat balance data for operational weather satellite system; transmitting 136.23; 136.92 mc.

OSO-I, U.S. 458 lbs.; THOR-DELTA; 3/7/62; 590/551; measure solar radiation in UV, X-ray and gamma ray regions; transmitting 136.744 mc.; ceased sending meaningful data May 22; resumed latter part of June.

COSMOS II, USSR not given; not given; 4/6/62; 1380/199; as listed by TASS: study ionosphere, low energy particles, Van Allen belt energy composition, cosmic rays, Earth's magnetic field, solar radiation, micrometeorites; reportedly satellites gathering data for USSR manned space flight program.

NONE, U.S. not given; ATLAS-AGENA B; 3/7/62; 617/233; not released; Discoverer-type.

NONE, U.S. not given; ATLAS-AGENA B; 4/9/62; 3380/2814; not released; probably a MIDAS type vehicle.

COSMOS III, USSR not given; not given; 4/24/62; 605/219; same as Cosmos II; reportedly functioning normally.

ARIEL, U.S.-U.K. 132 lbs.; THOR-DELTA; 4/26/62; 1205/396; study the ionosphere, solar radiation and cosmic rays carried six U.K. experiments; discovered "ledge" or layer above known ionospheric layers.

NONE, U.S. not given; THOR-AGENA B; 5/15/62; 627/287; not released; Discoverer-type vehicle.

COSMOS V, USSR not given; not given; 5/28/62; 1497/207; same as Cosmos II; transmitting 20.064 mc.

NONE, U.S. not given; THOR-AGENA B; 6/18/62; 408/367; not released; presumably SAMOS type vehicle.

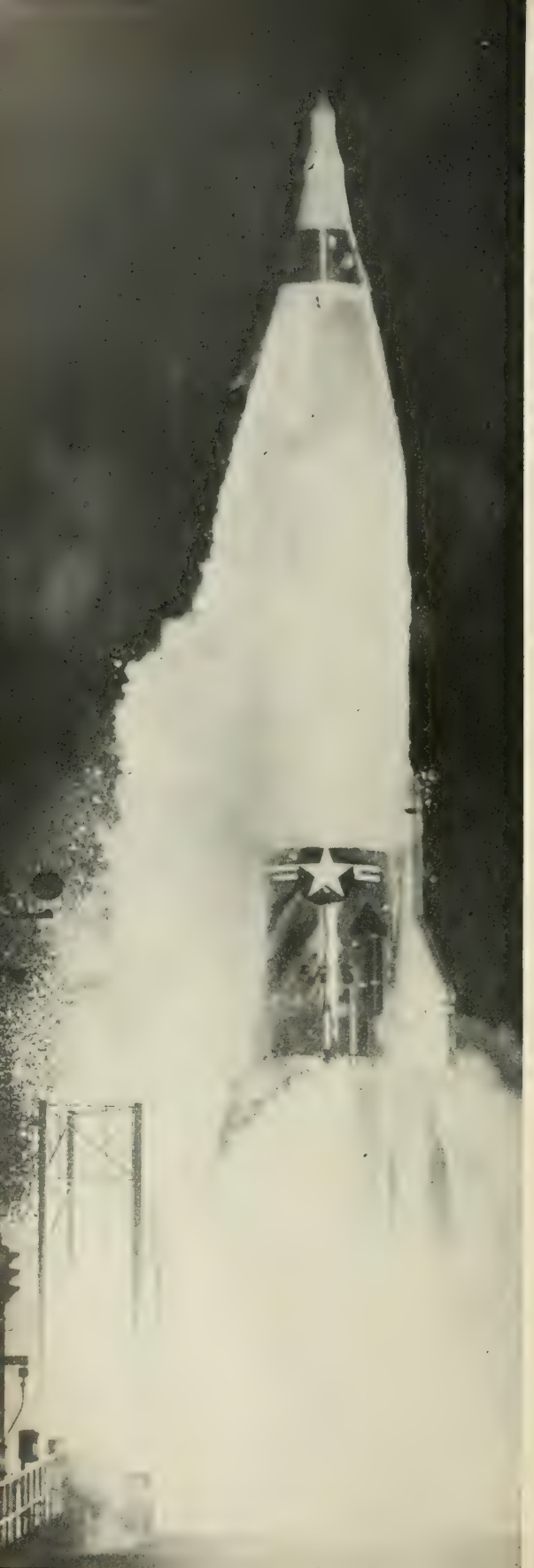
TIROS V, U.S. 285 lbs.; THOR-DELTA; 6/19/62; 976/586; gather data on ice-breakup in Northern latitudes and hurricane growth in S. Atlantic; transmitting 136.235; 136.922 mc.

NONE, U.S. not given; THOR-AGENA B; 6/23/62; 231/210; not released; presumably SAMOS type vehicle.

NONE, U.S. not given; ATLAS-AGENA B; 6/28/62; 689/210; not released; presumably Discoverer-type vehicle.

COSMOS VI, USSR not given; not given; 6/30/62; 346/262; same as Cosmos II; reportedly functioning normally.

TELSTAR, U.S. 170 lbs.; THOR-DELTA; 7/10/62; 5603/949; provide information on feasibility of low-altitude, active repeater communications satellites; measure effects of radiation on satellite systems and life time; communications satellite; developed by AT&T; successfully transmitted and received TV, telephone and radio signals from England and France.



MISSILES

Strategic

Atlas (Air Force)

MILITARY DESIGNATION: SM-65
TYPE: ICBM, surface-to-surface

STATUS: Operational

PRIME CONTRACTOR: General Dynamics/Astronautics

PERFORMANCE: Design Range—6300 mi.; Max. Range—in excess of 9000 mi.; Speed—about 16,000 mph

FRAME: System Contractor—General Dynamics; Length—82.5 ft.; Diameter—10 ft. (tank section), 16 ft. (missile base); Launch Wt.—266,000 lbs.; Material—Stainless Steel

GUIDANCE: Series D: Radio-inertial; System Contractors: General Electric, Burroughs (first four squadrons); Series E & F: All-inertial; System Contractor: American Bosch Arma Corp. (remaining nine squadrons)

PROPULSION SYSTEM: Series D: 2 MA-3 booster engines—each 150,000 lbs. thrust; sustainer engine—60,000 lbs. thrust; total thrust: over 360,000 lbs.; propellants: LOX/RP-1; Series E & F: 2 improved MA-3 engines—165,000 lbs. thrust each; sustainer—60,000 lbs.; same propellants

PAYLOAD: Nuclear warhead; reentry vehicle: System Contractors: General Electric (Mk 3), Avco (Series 4)

SUPPORT EQUIPMENT: Launch Facilities Integration—General Dynamics; Propellant Loading System—Arthur D. Little Co.; Propellant Utilization System—Acoustica Associates

REMARKS: 13 squadrons at 11 bases planned for total force; also used as space booster (see p. 67); Atlas D used as booster for Mercury program

Hound Dog (Air Force)

MILITARY DESIGNATION: GAM-77

TYPE: Air-launched strategic missile

STATUS: Operational

DEPLOYMENT: Two missiles carried by each B-52G bomber; used for suppression of enemy defenses; initially operational—1960; inventory expected to exceed 400

PRIME CONTRACTOR: North American Aviation, Inc.

PERFORMANCE: Range—approx. 600 n. mi.; Speed—about Mach 2; Ceiling—in excess of 50,000 ft.

FRAME: System Contractor—North American; Length—42.5 ft.; Height—9.3 ft.; Span—12.2 ft.; Launch Weight—9600 lbs.

GUIDANCE: System Contractor—Autonetics; Type—Inertial

PROPULSION SYSTEM: System Contractor—Pratt & Whitney; Engine—J-52 turbojet; Thrust—7500 lbs. at sea level

PAYLOAD: Nuclear warhead

REMARKS: Initially planned as an interim weapon until Skybolt became operational, Hound Dog will be retained in SAC and the number of missiles on a single B-52 increased from two to four

ATLAS F

Minuteman

MILITARY DESIGNATION: SM-80

TYPE: Surface-to-surface, ICBM

STATUS: Development

DEPLOYMENT:

SYSTEMS INTEGRATOR: The Boeing Co.

PERFORMANCE: Range—6300 mi.; Speed—more than 15,000 mph; Apogee—approx. 700 mi.

FRAME: Length—53.7 ft.; Diameter at inter-change structures—6.2 ft.; Launch Weight—more than 65,000 lbs.

GUIDANCE: System Contractor—Autonetics; Type—Inertial

PROPULSION SYSTEM—1st Stage—Thiokol; Type—Solid; 2nd Stage—Aerojet; Type—Solid; 3rd Stage—Hercules Powder; Type—Solid

PAYLOAD: Re-entry Vehicle—Avco; Type—Nuclear Warhead

SUPPORT EQUIPMENT: Launch Control System—Boeing; Handling & Servicing—Boeing; Launch Facilities—Peter Kiewit & Sons Co.; Transport Vehicle—Boeing

REMARKS: First Wing, Malmstrom AFB, Mont., to be operational late 1962; five bases with 16 "hardened and dispersed" squadrons (50 missiles each) are planned; rail-mobile system cancelled



MINUTEMAN

Mobile Medium Range Ballistic Missile

TYPE: Surface-to-surface

STATUS: Program Definition phase

PRIME CONTRACTOR: None announced

PEFORMANCE: Extremely mobile, short-reaction-time missile system designed to patrol the roads of Europe and the Far East; state-of-the-art missile would have a range of 300-1500 n. mi.

GUIDANCE: System Contractors—AC Spark Plug and General Precision, Inc. have contracts to develop feasibility of stellar-inertial guidance system for MMRBM

PROPULSION SYSTEM: Reportedly to be solid-fueled, although storable-liquids have not been ruled out

PAYLOAD: Nuclear warhead

SUPPORT EQUIPMENT: Entire system to be contained in one vehicle capable of maneuvering on the roads of Europe

REMARKS: Contracts for the development of six different parts of the system are unlikely to be awarded before September due to incomplete contractor data; one contractor will be named for systems integration; system is tied up in international questions of command and control

HOUND DOG





POLARIS

Polaris (Navy)

MILITARY DESIGNATION: FBM

TYPE: Submarine-launched, surface-to-surface or subsurface-to-surface

STATUS: A-1 and A-2 missiles operational; A-3, advanced development

DEPLOYMENT: 41 submarines (16 missiles each) planned; initially operational—1960

PRIME CONTRACTOR — Lockheed Missiles & Space Co., Lockheed Aircraft Corp.

PERFORMANCE: Range—1200 n. mi. (A-1), 1500 n.mi. (A-2), 2500 n.mi. (A-3); Speed—approx. 8000 mph.; Apogee—about 400 miles

FRAME: System Contractor—Lockheed; Length—28 ft. (A-1), 30.5 ft. (A-2, A-3); Diameter—4.5 ft.; Launch Weight—28,000 lbs. (A-1), about 30,000 (A-2, A-3); Material (major)—steel

GUIDANCE: System Contractor—General Electric/MIT; Hughes (backup); Raytheon/GE/MIT (A-2); Type—all inertial

FIRE CONTROL: System Contractor—General Electric

NAVIGATION SYSTEM: System Contractor — Sperry Gyroscope/Autonetics; Type—Inertial (SINS)

PROPULSION SYSTEM: System Contractor — Aerojet/Hercules; Type—2-stage solid; Thrust (1st stage)—about 100,000 lbs.; Material: steel casing both stages A-1 and first stage A-2, filament wound A-2 second stage and both stages A-3.

PAYLOAD: System Contractor (Reentry Vehicle)—Lockheed; Nuclear warhead

SUPPORT EQUIPMENT: Launcher—Westinghouse; Handling and Service — Lockheed/Westinghouse Transport Vehicle—Lockheed

REMARKS: Five submarines operational, sixth ready for sea. Lafayette, the eleventh SSBN, will be the first of a new class of submarines specifically designed for Polaris, launched May, 1962. A-3 missile is scheduled to join the fleet in 1964.



Quail (Air Force)

MILITARY DESIGNATION: GAM-72

TYPE: Air-launched Decoy Missile

STATUS: Operational

DEPLOYMENT: Carried aboard B-52 bombers to confuse and divert enemy warning networks and interceptors. Initially operational—1961

PRIME CONTRACTOR: McDonnell Aircraft Corp.

PERFORMANCE: Range—Classified (est. more than 200 n. mi.); Speed—Duplicates speed of B-52; Ceiling—over 50,000 ft.

FRAME: System Contractor — McDonnell; Length—12.9 ft.; Height—3.3 ft.; Span—5.5 ft.; Width (wings folded)—2.5 ft.

GUIDANCE: System Contractor—Guidance Technology, Inc. Type—Gyro autopilot

PROPULSION SYSTEM: System Contractor—General Electric; Engine—J-85-7; Thrust—2450 lbs.

PAYLOAD: System Contractor—Ramo-Wooldridge; Type — electronic countermeasures and B-52 simulation subsystems

SUPPORT EQUIPMENT: System Contractor—Bell Aerospace

REMARKS: Each B-52 can carry several Quail missiles which it releases as it approaches enemy defenses; procurement of Quail completed in FY '61

Skybolt (Air Force)

MILITARY DESIGNATION: GAM-87

TYPE: Air-to-surface

STATUS: Development

PRIME CONTRACTOR: Douglas Aircraft Co.

PERFORMANCE: Range — approx. 1000 n. mi.; Speed—hypersonic

FRAME: System Contractor—Douglas; Length—38.5 ft.; Launch Weight—9000 lbs.

GUIDANCE: System Contractor—Nortronics; Type—Stellar inertial

PROPULSION SYSTEM: System Contractor—Aerojet; Type—2 stage solid

PAYLOAD: Re-entry Vehicle—System Contractor—General Electric; Type—Nuclear warhead

REMARKS: Scheduled to be operational in 1964; four Skybolts will be carried by B-52G & H bombers and British Vulcan bombers; of three flight tests to date, one was partially successful

Slam (Air Force)

TYPE: Low-altitude, air-breathing intercontinental missile

STATUS: Component Development

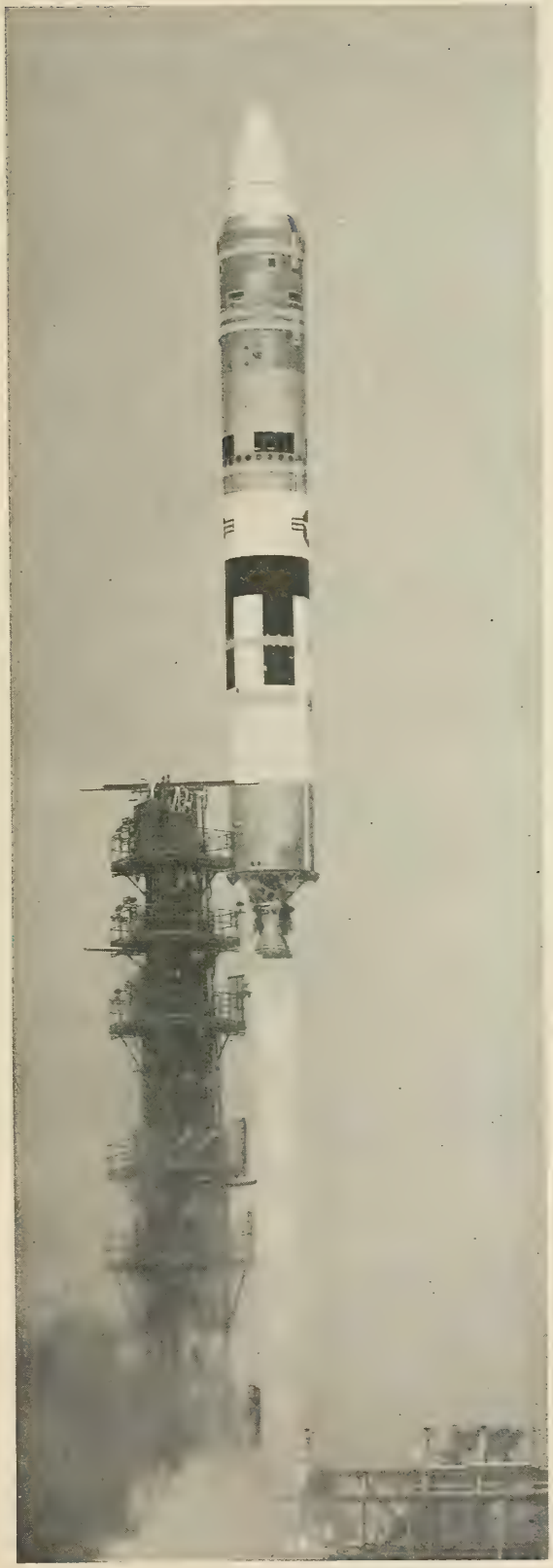
PRIME CONTRACTOR: Ling-Temco-Vought

PERFORMANCE: Nuclear-powered missile would have almost unlimited range and endurance and, because of its low-altitude capability, the possibility of greater penetration by flying under enemy defenses; estimated speed—over Mach 3; Guidance; probably will employ all-inertial with terrain-avoidance radar

PROPULSION SYSTEM: Lawrence Radiation Labs and NAA's Atomics International conducting power tests on Tory series of Reactors; Marquardt (under Project Pluto) is designing a nuclear-powered ramjet

PAYLOAD: Nuclear warhead

REMARKS: Tory tests have been highly successful; renewed DOD interest in low-altitude missile has spurred AF to authorize an expanded Tory effort by AEC



TITAN II

Titan I & II

MILITARY DESIGNATION: SM-68 A&B

TYPE: Surface-to-surface, ICBM

STATUS: Titan I, Operational; Titan II, Development

PRIME CONTRACTOR: The Martin Co.

PERFORMANCE: Range—more than 5500 mi.; Speed—8000 mph; Apogee—920 mi.

FRAME: System Contractor—Martin; Length—98 ft. (T-1), 103 ft. (T-II); Diameter—1st stage: 10 ft., 2nd: 8 ft. (T-I), 10 ft. both stages (T-II); Launch Weight—220,000 lbs. (T-I), 330,000 lbs. (T-II)

GUIDANCE: System Contractor—Bell Telephone Labs/Western Electric/Sperry/AC Spark; Type—Radio-Inertial (T-I); Inertial (T-II)

PROPULSION SYSTEM: Booster—Aerojet; Propellants — LOX-RP-1 (T-I), UDMH and Hydrazine/Nitrogen Tetroxide (T-II); Thrust—300,000 lbs. (T-1); 430,000 (T-II); Second Stage—Aerojet; Propellants—LOX-RP-1; Thrust—80,000 lbs. (T-1), 100,000 lbs. (T-II)

PAYLOAD: Re-entry Vehicle—Avco (T-I), General Electric (T-II); Type—Nuclear warhead

SUPPORT EQUIPMENT: American Machine & Foundry; Launch Facilities—Fluor Corp., Martin K. Eby & Associates; Morrison-Knudsen & Paul Hardeman, Inc.; Fueling—Air Products/Cambridge Corp.; Transport Vehicles—North American

REMARKS: Eight bases for 12 squadrons (9 missiles each) are planned. First Titan I Squadron at Lowry AFB declared operational in April; Titan II expected to become operational in early 1963. Titan II to be used as space booster for Gemini program and, with the addition of two 120-in. strap-on solids, basic launch vehicle for military space missions

Corporal (Army)

TYPE: Surface-to-surface

MISSION: Support of Army Corps

STATUS: Operational

DEPLOYMENT: Battalions deployed in Europe

PRIME CONTRACTOR: Jet Propulsion Laboratory

PERFORMANCE: Range—75 n. mi.; Speed—Supersonic

FRAME: System Contractor—Firestone Tire & Rubber Co.; Length—45 ft.; Diameter—30 in.; Launch Wt.—11,000 lbs.; Material—steel

GUIDANCE: System Contractor—Gilfillan Brothers, Inc.; Type—Preset and Command

PROPULSION SYSTEM: System Contractor — Ryan; Propulsion — Liquid (nitric acid & aniline)

PAYLOAD: HE or nuclear warhead

SUPPORT EQUIPMENT: Launching Equipment — Firestone; Ground Guidance Equipment — Gilfillan; Missile Containers—Fruehauf Trailer Corp.; Propellant valve, loading—Silas-Mason Corp.

REMARKS: To be replaced by solid-fueled Sergeant beginning in 1963.

Honest John (Army)

MILITARY DESIGNATION: M-50

TYPE: Surface-to-surface

MISSION: To provide close fire support to ground combat operations

STATUS: Operational

DEPLOYMENT: Deployed in U.S., Europe and Far East

PRIME CONTRACTOR: Douglas Aircraft Co.

PERFORMANCE: Range—12 miles; Speed—Mach 1.7

FRAME: System Contractor—Douglas/Emerson Electric; Length—25 ft.; Diameter—30 in.; Launch Weight—5913 lbs.; Material (major)—steel; aluminum (XM-50)

GUIDANCE: Free-flight, spin-stabilized, ballistic rocket

PROPULSION SYSTEM: System Contractor—Hercules Powder Co.; Propellant—Solid; Solid Spin Rockets—Thiokol

PAYLOAD: Conventional or nuclear warhead

SUPPORT EQUIPMENT: Launcher—Army Weapons Command

REMARKS: Honest John will be replaced by Missile B



CORPORAL



HONEST JOHN

Davy Crockett (Army)

MILITARY DESIGNATION: M-388

TYPE: Surface-to-surface

MISSION: Support of front-line Infantry and Armor troops

STATUS: Operational

DEPLOYMENT: To be deployed to Europe during FY '63

PRIME CONTRACTOR: Army Weapons Command in-house project

PERFORMANCE: Classified

CONFIGURATION: Bulbous, 279 mm super caliber projectile which is fired from a light (150 lbs.), 120 mm as well as a heavier (375 lbs.) 155 mm recoilless rifle. Launching pistons adapt the warhead to the smaller-caliber weapons

GUIDANCE: None

PAYLOAD: Conventional or low-yield nuclear warheads

SUPPORT EQUIPMENT: Both light and heavy versions can be mounted on ¼-ton trucks for mobility; both can also be disassembled and carried by the weapon crews

REMARKS: FY '63 funds provide for the procurement of the major portion of the inventory objective

Jupiter (Air Force)

MILITARY DESIGNATION: SM-78

TYPE: IRBM, Surface-to-surface

STATUS: Operational

DEPLOYMENT: Two squadrons deployed in Italy, two in Turkey; 15 missiles per squadron.

PRIME CONTRACTOR: Chrysler Corp.

PERFORMANCE: Range — 300 to 1500 mi.; Speed—10,000 mph; Apogee—about 350 miles

FRAME: System Contractor—Chrysler; Length—60 ft.; Diameter—8.75 ft.; Launch Weight—110,000 lbs.; Material—Aluminum

GUIDANCE: System Contractor—Ford Instrument Co.; Type—Inertial

PROPULSION SYSTEM: System Contractor—North American; Propellants—Kerosene and LOX; Thrust—150,000 lbs.

PAYLOAD: Re-entry Vehicle—Goodyear/CTL; Type—Nuclear warhead

SUPPORT EQUIPMENT: Chrysler

REMARKS: Developed by the Army Ballistic Missile Agency, Jupiter was turned over to the Air Force for deployment

Lacrosse (Army)

TYPE: Surface-to-surface

MISSION: Tactical support of ground troops—particularly by destroying hard point targets

STATUS: Operational

DEPLOYMENT: Eight units activated—three in Europe

PRIME CONTRACTOR: Martin Co. (Orlando)

PERFORMANCE: Range—less than 20 miles; Speed—Transonic

FRAME: System Contractor—Martin Co.; Length—19 ft.; Wingspan—108 in.; Diameter—20.5 in.; Launch Weight—2300 lbs.

GUIDANCE: System Contractor—Martin Co./Federal Div. ITT; Type—Command

PROPULSION SYSTEM: System Contractor—Thiokol; Type—Solid

PAYLOAD: Conventional or nuclear warhead

SUPPORT EQUIPMENT: System—contractor—Martin Co.; Launcher mounted on a standard Army truck

REMARKS: System initially developed by Cornell Aeronautical Laboratory; Lacrosse will be replaced by Missile B



LACROSSE

Little John (Army)

TYPE: Surface-to-surface

MISSION: For use in Army airborne operations

STATUS: Operational

DEPLOYMENT: Two battalions activated last year; each equipped with four launchers

PRIME CONTRACTOR: Army Ordnance Missile Command

PERFORMANCE: Range—10 miles; Speed—Supersonic

FRAME: System Contractor—Emerson Electric; Length—14½ ft.; Diameter—12½ in.; Weight—800 lbs.; Major materials—steel and aluminum

GUIDANCE: Free-flight, ballistic rocket

PROPULSION SYSTEM: System Contractor—Hercules Powder Co.; Propellant—Solid

PAYLOAD: Nuclear or conventional warhead

SUPPORT EQUIPMENT: Launcher—Ordnance Weapon Command/Consolidated Western Steel

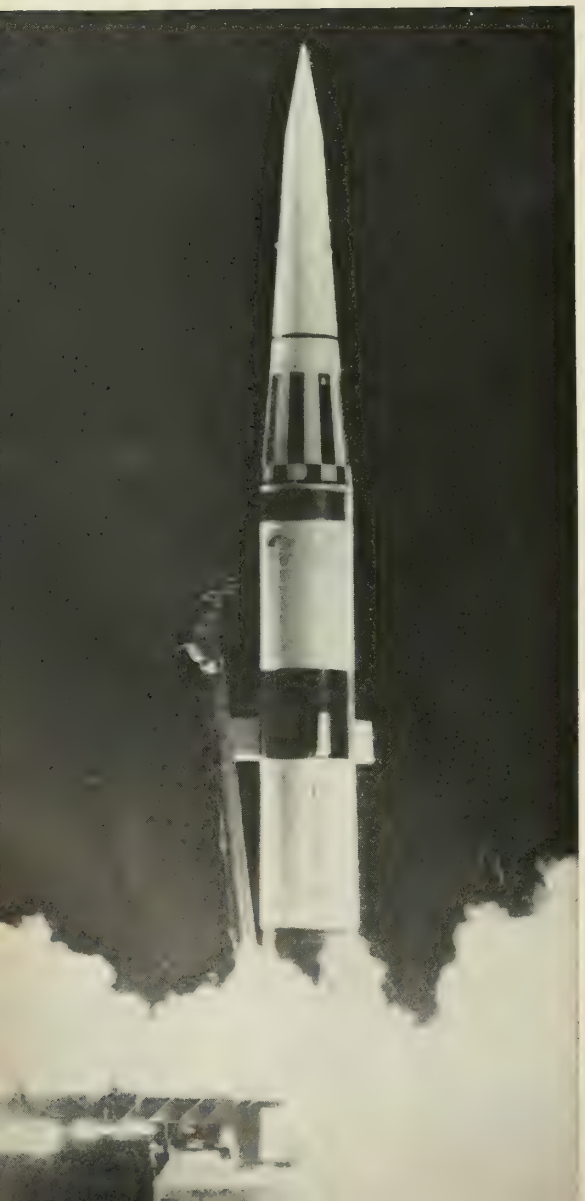
REMARKS: Highly mobile, air- and helicopter-transportable; similar to the larger Honest John

JUPITER



MACE

PERSHING



M-55 (Army)

TYPE: Surface-to-surface

STATUS: Operational

DEPLOYMENT: U.S. Troops both in this country and overseas; initially operational 1960

PRIME CONTRACTOR: Norris-Thermador Co.

PERFORMANCE: Relatively short-range area rocket; launched from 45-tube T-145 launcher

CONFIGURATION: Diameter—115 mm

GUIDANCE: Free-flight

PROPULSION SYSTEM: Solid-propellant

PAYLOAD: CW & BW agent warheads

Mace (Air Force)

MILITARY DESIGNATION: TM-76A & B

TYPE: Air-breathing, Surface-to-surface

STATUS: TM-76A — operational; TM-76B—acceptance testing

DEPLOYMENT: Three squadrons deployed in Germany; hardened facilities under construction

PRIME CONTRACTOR: The Martin Co.

PERFORMANCE: Range—Model A over 500 miles, B over 1200 mi.; Speed—more than 650 mph; Ceiling—above 40,000 ft.

FRAME: System Contractor—Martin; Length—44 ft.; Height—9.5 ft.; Span—22.75 ft.; Launch Weight — 18,000 lbs.; Material—Aluminum and Magnesium

GUIDANCE: A—Goodyear; Type—ATRAN (Automatic Terrain Radar and Navigator); B — AC Spark Plug; Type—Inertial

PROPULSION SYSTEM: Booster—Thiokol; Type — Solid; Thrust — 100,000 lbs.; Sustainer—Allison J-33-A-41; Thrust—5200 lbs.

PAYLOAD: Conventional or nuclear warhead

SUPPORT EQUIPMENT: A—Goodyear; B—Martin

REMARKS: Substantially improved version of Matador, which it replaced

Matador (Air Force)

MILITARY DESIGNATION: TM-61C

TYPE: Air-breathing, surface-to-surface

STATUS: Operational

DEPLOYMENT: Tactical Missile Squadrons in W. Germany, Korea and Taiwan; 2 Squadrons in Germany being turned over to German troops; initially operational —1951

PRIME CONTRACTOR: The Martin Co.

PERFORMANCE: Range—about 600 miles; Speed—approx. 650 mph; Ceiling—above 35,000 ft.

FRAME: System Contractor—Martin; Length—39.6 ft.; Height—9.67 ft.; Span—27.8 ft.; Launch Weight—approx. 10,000 lbs.; Material—Aluminum and Magnesium

GUIDANCE: System Contractor—Air Force; Type—Dual system including MSQ radar line of sight control and "Shanicle," which uses a hyperbolic grid system similar to Loran

PROPULSION SYSTEM: Booster—Thiokol; Type—Solid; Thrust—100,000 lbs.; Sustainer—Allison J-33-A-37 turbojet; Thrust—10,000 lbs.

PAYLOAD: Nuclear warhead

SUPPORT EQUIPMENT: Martin Co.

REMARKS: Essentially a pilotless bomber; being phased out of U.S. arsenal

Missile B (Army)

TYPE: Surface-to-surface

MISSION: Division general support weapon

STATUS: Component development

PRIME CONTRACTOR: None announced

PERFORMANCE: Range—about 3-30 miles

PROPULSION SYSTEM: Solid-propellant or prepackaged storable liquids

PAYLOAD: Conventional or nuclear warhead

REMARKS: Bidder's conference held at AOMC on June 15 with 80 companies represented; program definition proposals due July 15; two or more contractors will then be selected for 60-day program definition phase, after this a single prime contractor will be selected; Missile A has been absorbed within the mission capabilities of Missile B. Latter will replace Honest John and Lacrosse

Pershing (Army)

TYPE: Surface-to-surface

MISSION: Support of the Field Army

STATUS: Nearing end of flight test program; procurement of missiles and equipment in FY '63; First units to be ready for development in 4th Qtr. FY '63

PRIME CONTRACTOR: Martin Co. (Orlando, Fla.)

PERFORMANCE: Range—selective; about 350 miles max.; Speed—Supersonic

FRAME: System Contractor—Martin Co.; Length—34 ft.; Diameter—40 in.; Launch Weight—10,000 lbs.; Material—steel

GUIDANCE: System Contractor—Bendix, Eclipse Pioneer Div.; Type—Inertial

FUZING & ARMING SYSTEM: System Contractor—Ford Instrument Co.; Type—classified

PROPULSION SYSTEM: System Contractor—Thiokol Chemical Corp. (Redstone Div.); Type—2-stage, solid-propellant

PAYLOAD: Nuclear warhead

SUPPORT EQUIPMENT: XM 474 tracked vehicles — FMC Corp.; Transporter/Erector/Launcher—Universal Match Corp.; Communications Equipment—Collins Radio Co.

REMARKS: Short reaction time, highly mobile system to replace cumbersome Redstone; helicopter-transportable complete firing unit carried on 4 XM 474 vehicles. W. Germany is buying system.

Redstone (Army)

TYPE: Surface-to-surface

MISSION: Support of the Field Army

STATUS: Operational

DEPLOYMENT: Redstone Groups deployed in Europe since 1958

PRIME CONTRACTOR: Chrysler Corp.

PERFORMANCE: Range—200 miles; Speed—Supersonic

FRAME: System Contractor—Chrysler Corp.; Length—70 ft.; diameter—70 in.; Launch Weight—62,000 lbs.; Material—Steel; Ballistic Shells—Reynolds Metals Co.

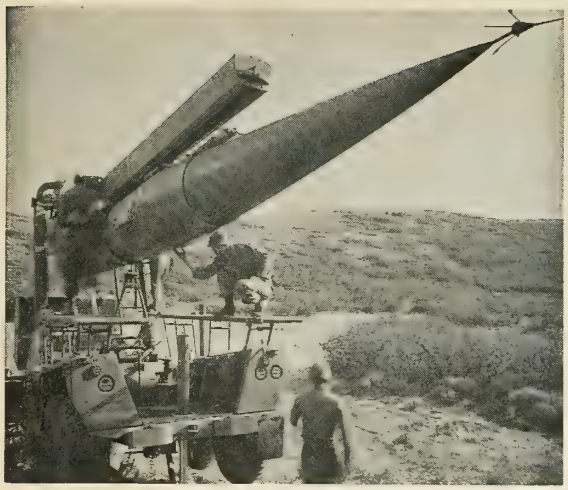
GUIDANCE: System Contractor—Sperry Farragut; Type—Inertial

PROPULSION SYSTEM: System Contractor—Rocketdyne Div., NAA; Propellant—Liquid; Thrust—78,000 lbs.

PAYLOAD: Nuclear warhead

SUPPORT EQUIPMENT: System Contractor — Chrysler; all GSE manufactured by Chrysler

REMARKS: To be replaced by Pershing; Modified Redstone also used in early Explorer program; man-rated vehicles used by NASA for Shepard and Grissom sub-orbital Mercury flights



SERGEANT

Regulus I

MILITARY DESIGNATION: SSM-N-8

TYPE: Air-breathing, surface-to-surface

STATUS: Operational

DEPLOYMENT: Five submarines (Growler, Barbero, Grayback, Tunny and nuclear-powered Halibut) and two cruisers (Los Angeles and Helena) equipped with Regulus. Initially operational—1954

PRIME CONTRACTOR: Ling-Temco-Vought

PERFORMANCE: Range—500 n.mi.; Speed—about 600 mph; Ceiling—about 40,000 ft.

FRAME: System Contractor—Ling-Temco-Vought; Length—34 ft.; Diameter—4.5 ft.; Wing Span—21 ft.; Launch Weight—14,000 lbs.; Material—aluminum

GUIDANCE: System Contractor—Sperry; Type—Inertial

PROPULSION SYSTEM: Booster: System Contractor—Aerojet; Type—Solid; Number—2; Thrust—33,000 lbs. each

SUSTAINER: System Contractor—Allison; Type—J33-18, Turbo-jet; Thrust: 4600 lbs.

PAYLOAD: High yield nuclear warhead

SUPPORT EQUIPMENT: Launcher—Fruehauf; Handling, Servicing & Fueling — Ling-Temco-Vought; Transport Vehicles—Fruehauf

REMARKS: Production terminated in 1958. Regulus II cancelled in December, 1958, because of obsolescence and Navy budgetary difficulties. Modernization program, begun during FY '61 and just completed, has retrofitted Regulus I's with inertial guidance



SHILLELAGH

Sergeant (Army)

TYPE: Surface-to-surface

MISSION: Support of Army Corps

STATUS: Production

DEPLOYMENT: First units to be deployed to Europe in 1st qtr., 1963.

PRIME CONTRACTOR: Sperry Utah Engineering Laboratory

PERFORMANCE: Range—75 n. mi.; Speed—Supersonic

FRAME: System Contractor—Sperry; Length—34.5 ft.; Diameter—31 in.; Launch Weight—10,000 lbs.; Materials—Steel & aluminum

GUIDANCE: System Contractor—Sperry; Type—Inertial; Gyroscopes—Minneapolis-Honeywell

PROPULSION SYSTEM: System contractor — Thiokol (Longhorn Works); Solid propellant; Employs drag brakes in terminal phase

PAYLOAD: Nuclear warhead

SUPPORT EQUIPMENT: Transport Trailers — Fruehauf Trailer Co.; Erector-Launcher — American Machine & Foundry Co.; Gas Turbine Generators—AiResearch Manufacturing Co.

REMARKS: Mobile, air-transportable system to replace Corporal

Shillelagh (Army)

TYPE: Surface-to-surface

MISSION: Close support of combat troops against Armor and field fortifications

STATUS: Development

PRIME CONTRACTOR: Aeronutronic Div., Ford Motor Co.

PERFORMANCE: Classified

CONFIGURATION: Diameter—152 mm

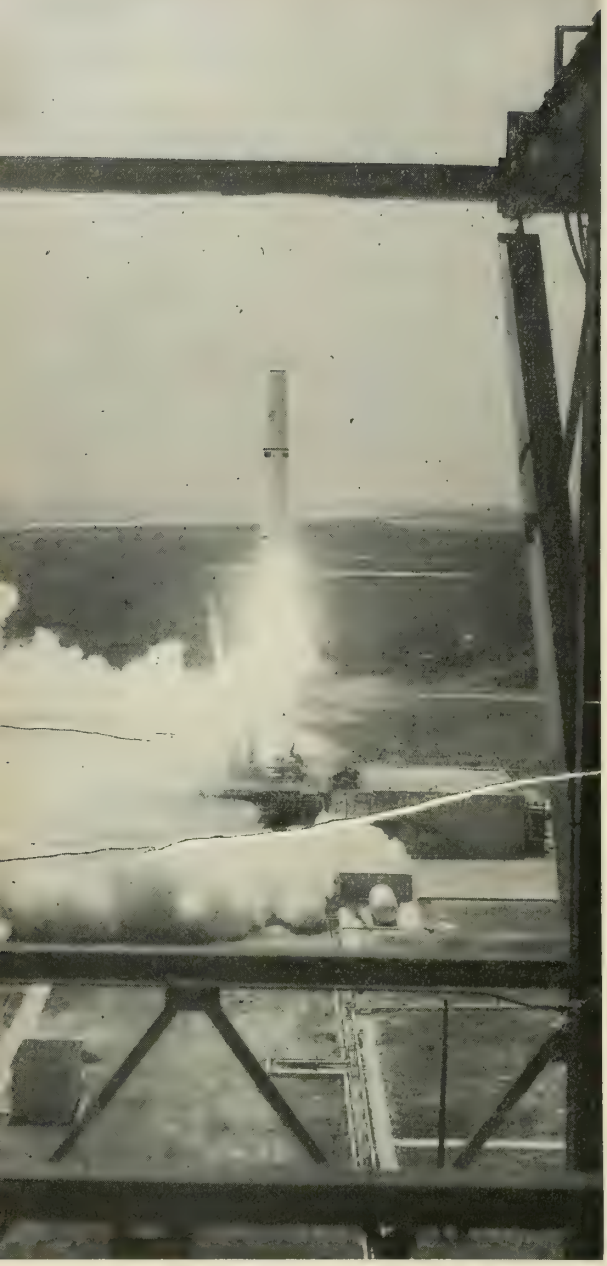
GUIDANCE: System Contractor—Aeronutronic; Type—Command

PROPULSION SYSTEM: System Contractor — Picatinny Arsenal/Amoco Chemicals Corp.; Motor cases—Norris Thermador; Type—Solid-propellant

PAYLOAD: Conventional or nuclear warhead

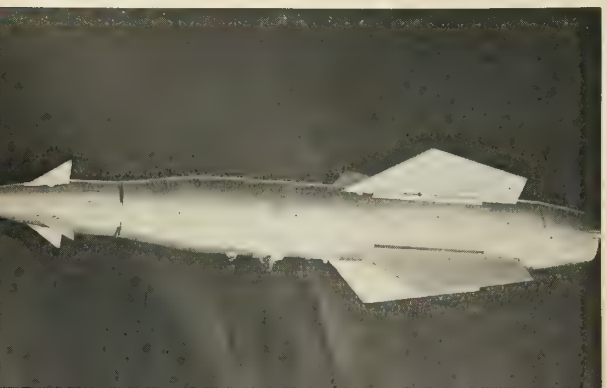
SUPPORT EQUIPMENT: Weapon system is tank-mounted

REMARKS: Expected to become operational in mid-1960's; considerable difficulty has been experienced with the guidance system, thus leading to a simpler, wire-guided scheme; AOMC responsible for missile development; Ordnance Tank-Automotive Command, complete system



THOR

BULLPUP



Thor (Air Force)

MILITARY DESIGNATION: SM-75

TYPE: Surface-to-surface

STATUS: Operational

DEPLOYMENT: Four squadrons of 15 missiles apiece deployed in England

PRIME CONTRACTOR: Douglas Aircraft Co.

PERFORMANCE: Range—1500 n. mi.; Speed—10,000 mph; Apogee —350 miles

FRAME: System Contractor—Douglas; Length—65 ft.; Diameter —8 ft.; Launch Weight—110,000 lbs; Material—Aluminum

GUIDANCE: System Contractor—AC Spark Plug; Type—Inertial

PROPULSION SYSTEM: System Contractor—North American; Propellants—LOX and JP-4; Thrust—150,000 lbs. (later versions, 165,-000 lbs.)

PAYLOAD: Re-entry Vehicle—General Electric; Type—Nuclear warhead

SUPPORT EQUIPMENT: Launcher — FMC Corp.; Fueling — DACO; Transport Vehicles—Fruehauf

REMARKS: Used extensively with various upper stages as a space booster; also used to boost nuclear warheads to extremely high altitudes during U.S. 1962 nuclear test series; reliability as space booster extremely good

Air-To-Surface

Bullpup (Navy/Air Force)

MILITARY DESIGNATION: ASM-N-7A; GAM-83A

TYPE: Air-to-surface

STATUS: Operational

DEPLOYMENT: Armament for Navy, Marine and Air Force aircraft; initially operational—April, 1959

PRIME CONTRACTOR: The Martin Co./Maxson Electronics Corp. (second source)

PERFORMANCE: Range — beyond 15,000 ft. (depending on altitude of firing aircraft); Speed—1400 mph.

FRAME: System Contractor—Martin/Maxson; Length—11 ft.; Diameter—12 in.; Launch Weight—573 lbs.

GUIDANCE: System Contractor—Martin/Maxson; Type—Radio link command (visual reference)

PROPULSION SYSTEM: System Contractor — Naval Propellant Plant/Thiokol; Type—Solid or storable propellant option

PAYLOAD: Conventional warhead

REMARKS: Advanced Navy Bullpup (ASM-7B) has larger warhead and new propulsion system; Advanced AF model (GAM-83B) has a nuclear warhead

Shrike (Navy)

TYPE: Air-to-surface, anti-radar missile

STATUS: Production

DEPLOYMENT: Initial fleet carrier and attack aircraft to be equipped with system during FY '63.

PRIME CONTRACTOR: Naval Ordnance Test Station (NOTS)

PERFORMANCE: Classified

CONFIGURATION: Classified

GUIDANCE: System Contractor—Texas Instruments; Type—(passive radar) Homing

PROPULSION SYSTEM: System Contractor—NOTS; Type—Solid

PAYLOAD: Conventional Warhead

REMARKS: Formerly called ARM

Anti-Tank

Entac (Army)

TYPE: Surface-to-surface

MISSION: Antitank weapon

STATUS: Operational

PRIME CONTRACTOR: Nord Aviation

PERFORMANCE: Range—6600 ft.; Speed—about 180 mph

FRAME: Weight with launcher—37 lbs.; weight without launcher—27 lbs.

GUIDANCE: Wire-guided

PROPULSION SYSTEM: Solid-propellant motor

PAYLOAD: HE shaped-charge warhead

SUPPORT EQUIPMENT: Control device for maneuvering missile to target after launch

REMARKS: Lightweight and compact, ENTAC—developed by the French—is being procured by the U.S. to replace the SS-10 (also French made)

Law (Light Anti-tank Weapon)

MILITARY DESIGNATION: M-72

TYPE: Antitank

STATUS: Operational

PRIME CONTRACTOR: Hesse-Eastern Div. of Flightex Fabrics Inc.

PERFORMANCE: Range — 10-500 yds.

FRAME: Length—25 in.; Diameter—3 in.; Weight—4.5 lbs.

GUIDANCE: Unguided

PROPULSION SYSTEM: Solid propellant

PAYLOAD: HE shaped-charge warhead

SUPPORT EQUIPMENT: Disposable carrying tube is also the launcher

REMARKS: Replaces rifle grenade and 3.5-in. rocket launcher

SS-10 and SS-11 (Army)

TYPE: Antitank

STATUS: Operational

DEPLOYMENT: U.S. units equipped with SS-10; SS-11 procured for evaluation tests

PRIME CONTRACTOR: Nord Aviation

PERFORMANCE: SS-10: Range—5250 ft.; Speed—180 mph. SS-11: Range—1650-11,500 ft.; Speed—more than 400 mph

FRAME: System Contractor—Nord; SS-10: Length—34 in.; Diameter—6 in.; Wing Span—30 in.; Launch Weight— 33 lbs. SS-11: Length—46 in.; Diameter—6 in.; Wing Span—20 in.; Launch Weight—63 lbs.

GUIDANCE: Remote control, wire-guided

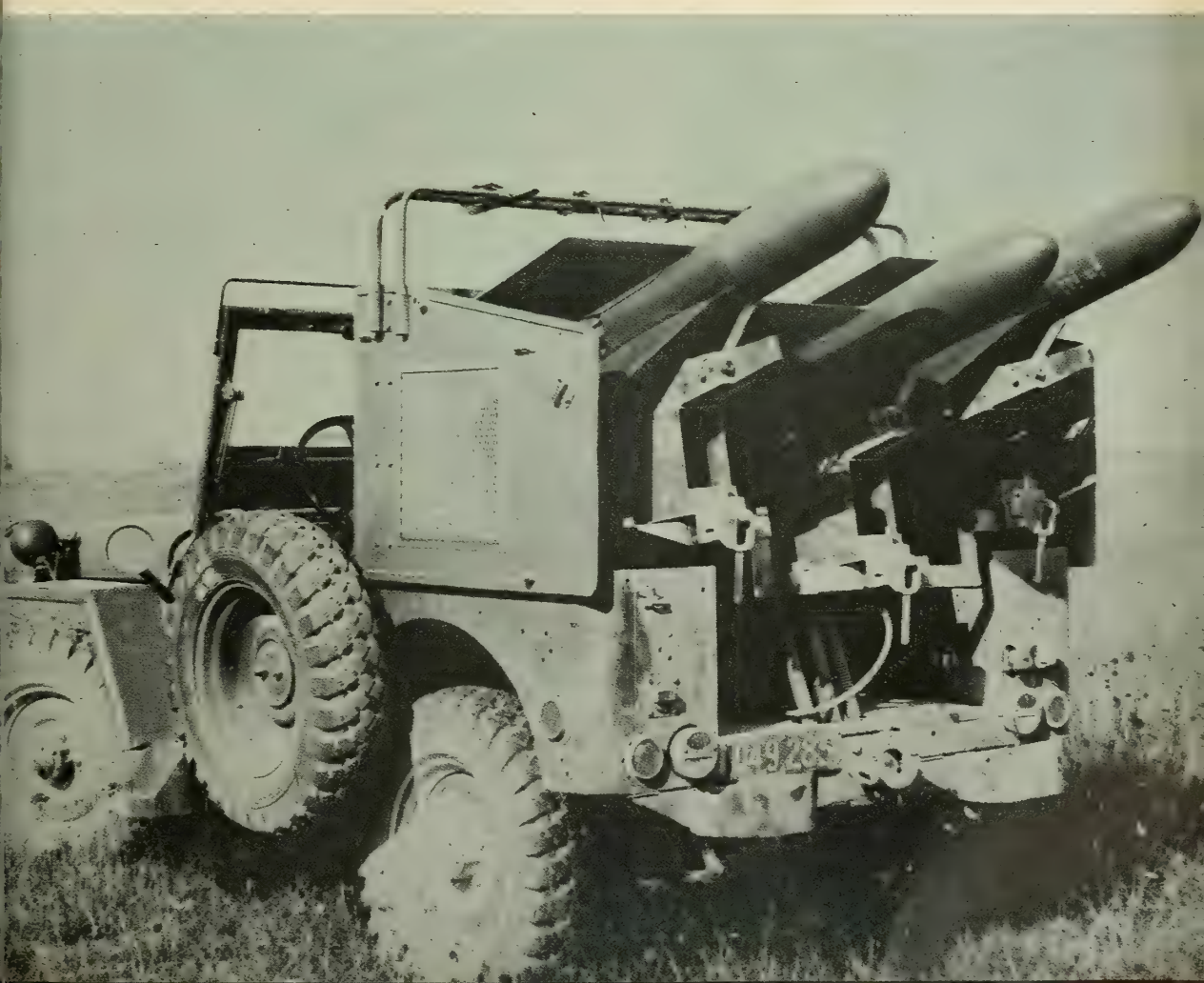
PROPULSION SYSTEM: Type—Solid-propellant

PAYLOAD: Armor-piercing, shaped-charge HE warhead

SUPPORT EQUIPMENT: Launched from ground, aircraft, helicopter or ground vehicle

REMARKS: SS-10 being replaced in U.S. arsenal with ENTAC

SS-11



Anti-Missile

Mauler (Army)

TYPE: Surface-to-air

STATUS: Development

PRIME CONTRACTOR: General Dynamics/Pomona

PERFORMANCE: Designed to destroy supersonic aircraft, short-range ballistic missiles and rockets in combat areas

FRAME: System Contractor—GD/Pomona; Length—about 6 ft; Diameter — approx. 5 in.; Launch Weight—120 lbs.; each firing unit has 12 missiles—three rows of four each

GUIDANCE: System Contractor—Hughes/deHavilland Aircraft; Type—Infrared acquisition

PROPULSION SYSTEM: Single-stage solid-propellant

PAYLOAD: Conventional warhead

SUPPORT EQUIPMENT: All the support equipment necessary to fire is contained in one weapon pod which is gyro-stabilized so the system can fire even on the move

REMARKS: Air- and helicopter-transportable, basic Mauler will be mounted on M-113-type tracked vehicle; program being accelerated in FY '63

Nike-Zeus (Army)

TYPE: Surface-to-air, anti-ICBM, IRBM & glide-type missiles

STATUS: Development

PRIME CONTRACTOR: Western Electric

PERFORMANCE: Range—about 200 n.m.; Speed—est. Mach 4

FRAME: System Contractor—Douglas; Length—48.3 ft.; Diameter (sustainer)—36 in.; Finspan—10 ft. (booster)

GUIDANCE: System Contractor—Western Electric; Type—Command

PROPULSION SYSTEM: System Contractor—Thiokol; Type—3-stage, solid-propellant (1st stage develops over 450,000 lbs. of thrust)

PAYLOAD: Nuclear warhead

SUPPORT EQUIPMENT: Launching and Handling Equipment—Douglas

REMARKS: Zeus successfully intercepted Atlas nose cone over Pacific July 19; however, future of Zeus is still in grave doubt in light of statements by Secretary of Defense that Kwajalein tests won't influence the decision to deploy Zeus; DOD intimates that Zeus has at most two more years of life as research program (total program cost expected to be $1.7 billion). Cost of operational Zeus system put at $10 billion. If deployment decision were made today, initial operational capability would be late 1966. Army proposing improved Radar and Sprint missile in attempt to meet DOD objections to system

Typhon (Navy)

TYPE: Surface-to-air (antimissile missile)

MISSION: Fleet Air Defense against the anticipated 1970 threat

STATUS: Development

DEPLOYMENT: Norton Sound being converted for system; nuclear-powered frigate is also being built

PRIME CONTRACTOR: Bendix; Design and Development under Bumblebee program — Applied Physics Lab

PERFORMANCE: Range—est. 200 mi.; Speed—Supersonic; Ceiling—Classified

CONFIGURATION: System will consist of two guided missiles—Typhon Long Range (formerly Super-Talos) and Typhon Medium Range (formerly Super-Tartar); System contractor—McDonnell

GUIDANCE: Weapons direction system and radar—Westinghouse

PROPULSION SYSTEM: System Contractor — McDonnell; Type — Solid rocket booster, ramjet sustainer

PAYLOAD: Conventional warhead

REMARKS: Extreme expense of system may delay development; DOD evaluating cost/effectiveness



NIKE-ZEUS



BOMARC

Bomarc A and B (Air Force)

MILITARY DESIGNATION: IM-99A and B

TYPE: Surface-to-air

STATUS: Operational

DEPLOYMENT: IM-99A: Squadrons of 28-56 missiles based at Suffolk County AFB, N. Y., McGuire AFB, N. J.; Otis AFB, Mass,; Dow AFB, Me., and Langley AFB, Va.; IM-99B: Squadrons of 28 missiles at Otis, Langley, McGuire, Niagara, N. Y., Duluth AFB, Minn., Kincheloe AFB, Mich., North Bay RCAF Station, Ont., and LaMacaza RCAF Station, Quebec.

PRIME CONTRACTOR: The Boeing Co.

PERFORMANCE: Range—200 n. mi. (B: over 400); Speed—Mach 2.5 (B: 2.7); Ceiling—over 68,000 ft. (B: over 70,000)

FRAME: System Contractor—Boeing; Length—46 ft., 9 in. (B: 45 ft.); Diameter—35 in. both; Wing Span—18 ft., 2 in. both; Launch Weight—15,000 lbs. (B: 16,000); Materials — Aluminum, magnesium and stainless steel

GUIDANCE: System Contractor—IBM/Westinghouse; Type — Command and Radar homing (SAGE guides missile to target then active homing radar assumes command for final maneuvers)

PROPULSION SYSTEM: IM-99A; Booster — Aerojet; Type — Liquid; Thrust — 35,000 lbs.; Sustainer — Marquardt; Type—2 RJ-43 ramjets; Thrust—10,000 lbs. each; IM-99B: Booster — Thiokol; Type — Solid; Thrust — 50,000 lbs.; Sustainer—Marquardt; Type—2 advanced RJ-43 ramjets; Thrust—1270 lbs. each

SUPPORT EQUIPMENT: Launcher-Erector—FMC Corp.

REMARKS: Production completed on A Model; Canadian squadrons being activated this year



HAWK

Hawk (Army)

TYPE: Surface-to-air

STATUS: Operational

DEPLOYMENT: Battalions deployed in Europe, Far East & Panama; 2 battalions operational with Marine units

PRIME CONTRACTOR: Raytheon Co.

PERFORMANCE: Range—about 22 n.m.; Ceiling—less than 100 ft. to 38,000 ft.; Speed—Supersonic

FRAME: System Contractor—Nortronics; Length—16.8 ft.; Diameter—14 in.; Launch Weight—1275 lbs.; Material—aluminum and steel

GUIDANCE: System Contractor—Raytheon; Type—Semi-active radar-homing

PROPULSION SYSTEM: System Contractor—Aerojet-General; Type—Single-chamber solid-propellant motor

PAYLOAD: Conventional warhead

SUPPORT EQUIPMENT: Mechanical GSE—Nortronics; Guidance GSE—Raytheon; Test Equipment—RCA; Launcher-Loader Carrier — FMC; Radar Pedestals—Bendix; Radar Antennas—Goodyear Aircraft

REMARKS: Although Hawk is designed for defense against low-flying aircraft, it has successfully intercepted Honest John, Little John and Corporal missiles in tests. Units to be modified during FY '63 to further improve performance

Nike-Ajax (Army)

TYPE: Surface-to-air

STATUS: Operational

DEPLOYMENT: Deployed in U.S. with National Guard units. Also in Europe and the Far East

PRIME CONTRACTOR: Western Electric Co.

PERFORMANCE: Range—25 n.m.; ceiling—60,000 ft.; Speed—Supersonic

FRAME: System Contractor—Douglas; Length with booster—31 ft.; Diameter—12 in.; Launch Weight—2300 lbs.; Material—aluminum and steel

GUIDANCE: System Contractor—Western Electric; Type—Command

PROPULSION SYSTEM: System Contractor — Thiokol; Booster — Solid Propellant; Sustainer—Liquid

PAYLOAD: Conventional warhead

SUPPORT EQUIPMENT: Launchers — Consolidated Western Steel; Transport Vehicles—Fruehauf; Ground Guidance—Western Electric

REMARKS: Last 19 Nike-Ajax units in U.S. being phased out; to be replaced by Nike-Hercules battalions

Nike-Hercules (Army)

TYPE: Surface-to-air

STATUS: Operational

PRIME CONTRACTOR: Western Electric

PERFORMANCE: Range—over 75 mi.; Speed—Supersonic; Ceiling—over 150,000 ft.

FRAME: System Contractor—Douglas; Length with booster—39 ft.; diameter—31.5 in.; Finspan—90 in.; Launch Weight—10,000 lbs.; Material—aluminum and steel

GUIDANCE: System Contractor—Western Electric; Type—Command

PROPULSION SYSTEM: Booster: System Contractor—Hercules Powder; Type—Four clustered Nike-Ajax solid-propellant motors; Sustainer: System Contractor—Thiokol; Type—solid

PAYLOAD: Conventional or nuclear warhead

SUPPORT EQUIPMENT: Launchers —Consolidated Western Steel; Transport Vehicles—Fruehauf; Ground Guidance—Western Electric

REMARKS: System capable of intercepting tactical missiles. U.S. units being manned by Army National Guard units. Hercules deployed in Europe and on Formosa

Redeye (Army)

TYPE: Surface-to-air

MISSION: Individual protection against low-flying aircraft

STATUS: Development; limited procurement authorized

PRIME CONTRACTOR: General Dynamics/Pomona

PERFORMANCE: Classified

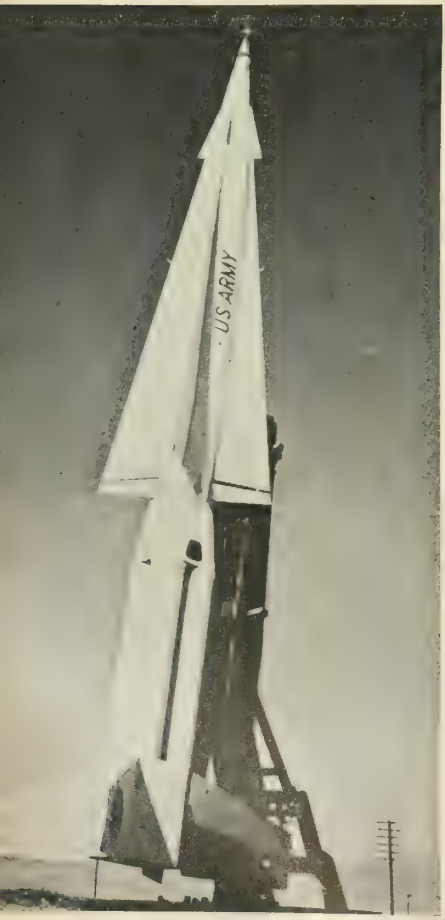
FRAME: System Contractor—GD/Pomona; Launcher—"bazooka" type; Length—44 in.; Diameter—2.75 in.; Weight—22 lbs.; Missile—wingless cylinder

GUIDANCE: System Contractor—Philco, GD/Electronics; Type—Infrared homing with retractable steering fins

PROPULSION SYSTEM: System Contractor — Atlantic Research; Type—solid

PAYLOAD: High-explosive warhead

REMARKS: Full production plans modified by disappointing system tests; Marines will also buy system; launcher disposable



NIKE-HERCULES



REDEYE



TALOS



TARTAR

Talos (Navy)

MILITARY DESIGNATION: SAM-N-6

TYPE: Surface-to-air (also used in surface-to-surface role against ships and shore targets)

STATUS: Operational

DEPLOYMENT: USS Galveston first ship equipped with Talos, five other guided missile cruisers also have weapon; nuclear-powered USS Long Beach. Initially operational—1959

PRIME CONTRACTOR: Bendix Corp. System Engineering—Vitro Corp.

PERFORMANCE: Range—more than 65 n.mi.; Speed—Supersonic (about Mach 2.5); Ceiling—extremely high altitude

FRAME: System Contractor—McDonnell; Length—about 30 ft.; Diameter—about 30 in.; Launch Weight—7000 lbs. (4000 lbs. booster)

GUIDANCE: System Contractor—Sperry; Type—radar beam riding/semi-active homing

PROPULSION SYSTEM: Booster: System Contractor—Allegany Ballistic Lab.; Type—solid fuel; Sustainer: System Contractor—Allegany; Type—Ramjet

PAYLOAD: Nuclear or conventional warhead

SUPPORT EQUIPMENT: Launchers—Naval Weapons Plant

REMARKS: Part of the Navy's Bumblebee Missile program, begun at the Applied Physics Laboratory in 1944, to develop better air defense systems for Navy ships.

Tartar (Navy)

TYPE: Surface-to-air

STATUS: Operational

DEPLOYMENT: Programed for 27 destroyers and three cruisers; primary antiaircraft armament destroyers, secondary for cruisers

PERFORMANCE: Range—more than 10 n. mi.; Speed—Supersonic

FRAME: System Contractor—GD/Pomona; Length—15 ft.; Diameter—less than 18 in.; Weight—about 1500 lbs.

GUIDANCE: System Contractor—Raytheon; Type—Radar beam-riding

PROPULSION SYSTEM: System Contractor—Aerojet; Type—Dual-thrust, solid-propellant rocket motor

PAYLOAD: Conventional warhead

SUPPORT EQUIPMENT: Launcher—Puget Sound Naval Shipyard; Handling equipment—Naval Plant/Washington Technological Associates

REMARKS: Navy awarded contracts early this year for three new guided missile escort ships to be equipped with Tartar. Ships designed as part of hunter-killer group

Terrier (Navy)

MILITARY DESIGNATION: SAM-N-7

STATUS: Operational

DEPLOYMENT: Three cruisers, one destroyer and a number of frigates armed with Terrier; Frigate USS Dewey first ship armed with improved Terrier

PRIME CONTRACTOR: General Dynamics/Pomona; Systems Engineering—Vitro Corp.

PERFORMANCE: Range—about 10 n. mi.; Speed—Supersonic; Ceiling—more than 60,000 ft.

FRAME: System Contractor—GD/Pomona; Length—27 ft.; (booster: 12 ft.); Diameter—about 1 ft.; Weight—about 3000 lbs.

GUIDANCE: System Contractor—Sperry; Type—Radar beam-riding

PROPULSION SYSTEM: Booster and Sustainer: System Contractor—Naval Propellant Plant (loading); Type—Solid; Motor cases—Cameron Iron Works, Temco Aircraft Corp., Borg-Warner Corp.

PAYLOAD: Conventional warhead

SUPPORT EQUIPMENT: System Contractor Launchers and Power Drives—Northern Ordnance, Inc.

REMARKS: Advanced Terrier has improved guidance and substantially better coverage; mobile ground launchers for use with Marines; four carriers, six cruisers and 23 frigates under construction or conversion capable of using Terrier

Anti-Submarine



ASROC

SUBROC



Alfa (Navy)

TYPE: ASW, Surface-to-underwater

STATUS: Operational

DEPLOYMENT: Aboard U.S. destroyers and cruisers; initially operational—1952

PRIME CONTRACTOR: Navy

PERFORMANCE: Range—Variable; max. about 900 yds.

FRAME: System Contractor—Avco; Length—8.5 ft.; Diameter—12.75 in.; Launch Weight—500 lbs.

GUIDANCE: Free-flight rocket

PROPULSION SYSTEM: System Contractor—Naval Propellant Plant; Type—Solid

PAYLOAD: HE depth charge

REMARKS: Alfa is launched from turret-mounted guns

Asroc (Navy)

TYPE: ASW, Surface-to-underwater

STATUS: Operational

DEPLOYMENT: Destroyers, destroyer escorts, heavy cruisers, and guided missile frigates scheduled to get the system; initially operational—1960

PRIME CONTRACTOR: Minneapolis-Honeywell

PERFORMANCE: Range—about 8 n. mi.; Speed—nearly Mach 1

FRAME: System Contractor—Minneapolis-Honeywell / General Mills; Length—15 ft.; Torpedo-Warhead Length—100 in.; Diameter—12 in.; Span—2.5 ft.; Launch Weight—1000 lbs.

GUIDANCE: Unguided

FIRE CONTROL: System Contractor—Librascope; Type—Digital computer

SONAR DETECTION SYSTEM: System Contractor—Sangamo Electric; Type—SQS-23

PROPULSION SYSTEM: System Contractor — Naval Propellant Plant; Type—Solid

PAYLOAD: System Contractor—General Electric; Type — Acoustic homing torpedo or depth charge (conventional)

SUPPORT EQUIPMENT: Launcher—Universal Match

REMARKS: Improved Mark 44 torpedo under development

Astor (Navy)

TYPE: ASW, Underwater-to-underwater

STATUS: Development

DEPLOYMENT: To be aboard hunter-killer subs

PRIME CONTRACTOR: Westinghouse Electric Corp.

PERFORMANCE: Range — est. 11 n. mi.

FRAME: System Contractor—Westinghouse; Length (less booster)—about 20 ft.; Launch Weight—more than 2000 lbs.

GUIDANCE: Wire-guided

PROPULSION SYSTEM: Type—solid

PAYLOAD: Mark 45 torpedo with nuclear or HE warhead

Subroc (Navy)

TYPE: ASW, Underwater-surface-underwater

STATUS: Operational

DEPLOYMENT: Nuclear-powered attack sub Thresher first ship equipped with system

PRIME CONTRACTOR: Goodyear Aircraft Corp.

PERFORMANCE: Range—about 25 n. mi.

FRAME: System Contractor—Goodyear Aircraft

GUIDANCE: System Contractor—Kearfott

FIRE CONTROL: System Contractor—Librascope

AUXILIARY POWER: System Contractor—AiResearch

PROPULSION SYSTEM: System Contractor—Thiokol; Type—solid

PAYLOAD: Nuclear or HE warhead

REMARKS: Fired through torpedo tubes; reportedly tested during 1962 U.S. Nuclear tests in the Pacific.



GENIE



FALCON

Air-To-Air

Genie (Air Force)

MILITARY DESIGNATION: MB-1

TYPE: Air-to-air

STATUS: Operational

DEPLOYMENT: Used by fighter-interceptors of the Air Defense Command; initially operational—Jan. 1, 1957

PRIME CONTRACTOR: Douglas Aircraft Co.

PERFORMANCE: Range—about 6 miles; Speed—about Mach 3; Ceiling—above 50,000 ft.

FRAME: System Contractor—Douglas; Length—114.86 in.; Diameter—17.35 in.; Launch Weight—about 800 lbs.

GUIDANCE: Unguided, free-flight rocket

PROPULSION SYSTEM: System Contractor—Aerojet; Type—Solid; Thrust—about 36,000 lbs.

PAYLOAD: Nuclear warhead

SUPPORT EQUIPMENT: Launcher, Handling & Servicing Equipment—Douglas; Transport Vehicles—Fruehauf

Falcon (Air Force)

MILITARY DESIGNATION: Gar-1, -2,-3,-4,-9,-11

TYPE: Air-to-air

STATUS: All but GAR-9 operational; GAR-9, under development

DEPLOYMENT: Assigned to operational units of the Air Defense Command since 1957; can be carried by F-89, F-101, F-102 and F-106 aircraft

PRIME CONTRACTOR: Hughes Aircraft Co.

PERFORMANCE: Range — beyond 5 n. mi.; Speed—Supersonic; Ceiling—above 50,000 ft. (Greater performance characteristics for GARs 3 thru 11)

FRAME: System Contractor—Hughes; Length—6.5 ft. (-11 approx. 7 ft.); Diameter—6 in. (-11, about 11 in.); Launch Weight—over 100 lbs. (-11, over 200 lbs.); Span—20 in.

GUIDANCE: System Contractor—Hughes; Type—Active radar homing (-1D), IR Homing (-2A), active radar homing (-3A), Improved IR (-4A), hybrid IR Radar Homing (-11)

PROPULSION SYSTEM: System Contractor—Thiokol; Type—Solid; Thrust — (varies with missile) — about 6000 lbs.

PAYLOAD: Conventional warhead (GAR 1 thru 9); nuclear warhead (GAR-11)

REMARKS: Inventory objectives for all missiles achieved during FY '62; GAR-9 is continuing under a reduced rate and slightly relaxed requirements, pending the development of requirements for the F-108 satisfactory to DOD



SPARROW III

Sidewinder 1A and 1C (Navy)

MILITARY DESIGNATION: AAM-N-7 (Navy), GAR-8 (Air Force)

TYPE: Air-to-air

STATUS: 1A—Operational; 1C—Production

DEPLOYMENT: Carrier-based aircraft and AF Century fighters; also used by NATO and Chinese Nationalist forces

PRIME CONTRACTOR: Naval Ordnance Test Station; 1C—Philco/Motorola

PERFORMANCE: 1A—Range—Classified; Speed—Supersonic; Ceiling over 50,000 ft.; 1C: faster and longer range version of 1A

FRAME: System Contractor—Norris Thermador / Hunter-Douglas; Length—9 ft.; Diameter—5 in.; Launch Weight—about 155 lbs.; 1C: comparable dimensions

GUIDANCE: System Contractor—Philco/General Electric; Type—IR heat-seeking device

PROPULSION SYSTEM: System Contractor — Naval Propellant Plant; Type—solid; Metal parts—Norris-Thermador

PAYLOAD: Conventional warhead

REMARKS: Operational in 1956; 1A was highly successful during the 1958 Quemoy crisis; 1C will have switchable IR and radar-guided warheads

Sparrow III (Navy)

MILITARY DESIGNATION: AAM-N-6A

TYPE: Air-to-air

STATUS: Operational

DEPLOYMENT: Carrier-based aircraft and marine units; initially operational—August, 1958

PRIME CONTRACTOR: Raytheon

PERFORMANCE: Range—more than 5 n. mi.; Speed—over 1500 mph; Ceiling—over 50,000 ft.

FRAME: System Contractor—Raytheon; Length—about 12 ft.; Diameter—8 in.; Launch Weight—about 350 lbs.

GUIDANCE: System Contractor—Raytheon; Type — Electronically-controlled homing (active radar)

PROPULSION SYSTEM: System Contractor—Aerojet; Type—solid

PAYLOAD: Conventional warhead

REMARKS: Gives the Navy a weapon for Fleet defense against high-performance aircraft in all kinds of weather and from all aspects, including head-on. Advanced Sparrow III will be used by F4H.

Zuni (Navy)

TYPE: Air-to-air

STATUS: Operational

DEPLOYMENT: Carrier based aircraft; initially operational—1957

PRIME CONTRACTOR: Naval Ordnance Test Station

PERFORMANCE: Range—about 5 n.mi.; Speed—over Mach 2

FRAME: Length—110 in.; Diameter—5 in.; Launch Weight—107 lbs.

GUIDANCE: Unguided

PROPULSION SYSTEM: System Contractor—Hunter-Douglas; Type—Solid; Thrust—7000 lbs.

PAYLOAD: Conventional warhead

REMARKS: Folding fin, all-weather rocket; AD-type aircraft can carry 48 Zunis

Drones

AN/USD-5, Surveillance Drone (Army)

MISSION: Primarily to provide reconnaissance data on deep battlefield targets in support of Sergeant and Pershing-class missile systems

STATUS: Development

PRIME CONTRACTOR: Fairchild Stratos Corp.

PERFORMANCE: Max. speed—classified; Endurance — Classified; Max. range—over 2000 mi. Altitude range—from "a few hundred feet" to 35,000 ft.

CONFIGURATION: Span—296 in.; Length—432 in.; Launch wt.—8500 lbs.; Major materials—aluminum (fuselage); fiber glass-honeycomb (wings)

GUIDANCE: System contractor—Minneapolis-Honeywell; Type—Inertial navigational system; Digital processor and programer — Hughes Aircraft Co.; Radio command backup

INSTRUMENTATION: System contractor—Texas Instruments; Types—KA-30 or T-11 reconnaisance camera, AN/AUS-5 IR sensor system; and a side-looking radar

PROPULSION SYSTEM: Booster—System Contractor: Picatinny Arsenal; Type: 4000-lb.-thrust solid-propellant motor; Sustainer—J-60 Pratt & Whitney 3000-lb.-thrust, turbojet engine

PAYLOAD: Surveillance equipment, CW & BW dispersal mechanisms, cargo delivery system or meteorological instruments

SUPPORT EQUIPMENT: System Contractor—Fairchild Stratos; Launcher—Zero length; Recovery System—Two 78-ft. parachutes

REMARKS: Scheduled to be operational in late 1963; flight-testing began in mid-1960; to date SD-5 has recorded 13 successes, 2 partials and 4 failures; future of surveillance drones reportedly hinges on success of the program

Firebee, Target Drone

MILITARY DESIGNATION: Q-2A (AF); KDA-4 (Navy)

STATUS: Operational

PRIME CONTRACTOR: Ryan Aeronautical Co.

PERFORMANCE: Max. Speed—575 mph; Service Ceiling—40,000 ft.; Endurance—60 min.

CONFIGURATION: Span—135 in.; Length—211 in.; Height—75 in.; Max. weight—1848 lbs.

GUIDANCE: Radio command and radar

PROPULSION SYSTEM: One Continental J-69-T-19 engine with 1000 lbs. thrust (Q-2A); one Fairchild J-44-R-20 engine with 1000 lbs. thrust (KDA-4)

SUPPORT EQUIPMENT: Air- or ground-launched; recoverable by parachute

REMARKS: Used by Air Defense Command as primary target in the William Tell Weapons Meets at Tyndall AFB, Fla., in 1958-59.

Firebee, Target Drone (Air Force)

MILITARY DESIGNATION: Q-2C

STATUS: Operational

PRIME CONTRACTOR: Ryan Aeronautical Co.

PERFORMANCE: Max. Speed—625 mph; Service ceiling—59,800 ft.; Endurance—75 to 96 min. at 50,000 ft.

CONFIGURATION: Span—153 in.; Length—274 in.; Height—79 in.; Max. weight—2500 lbs.

GUIDANCE: Radio command and radar

PROPULSION SYSTEM: One Continental J-69-T-29 with 1700 lbs. thrust

SUPPORT EQUIPMENT: Air- or ground-launched; recoverable by parachute

REMARKS: Army and Navy also use system; target vehicle for 1961 William Tell meet; primary using commands are Air Defense Command and the Systems Command; Army Designation: 124-E

FUTURE MILITARY SYSTEMS

Advanced Spacecraft

Project	Contractors	Description	Status
BAMBI (AF)	GD/Astronautics, STL	Satellite-based system utilizing interceptors to destroy missiles in boost phase	Study
BOSS (AF)	Lockheed/AiResearch	Biological Orbiting Space Station to provide data on long-term (up to two weeks) effects of weightlessness and radiation on primates	Study; program may be approved this year
GSS (AF)	No contracts announced	Global Surveillance System	Study
SMART (AF)	No contracts announced	Space Maintenance and Repair Techniques	Study
MODS (AF)	No contracts announced	Manned Orbiting Development Station (also known as MOSS and MTSS) to test in space environment components and techniques under development	Study; program may also be approved; could become joint NASA/AF project
SLOMAR (AF)	Martin	Space Logistics, Maintenance and Repair	Study
YO-YO (NAVY)	No contracts announced	Tactical sea-launched one-pass reconnaissance satelloid	Study

Advanced Tactical Missiles

FABMDS (ARMY)	GD/Astronautics, Hughes, Martin, GE, Raytheon, Sylvania (feasibility studies)	Mobile defense system for antimissile defense of the field Army	Studies evaluated by panels of experts, but initiation of development delayed, presumably by DOD
HAAW (ARMY)	No contracts announced	Heavy Antitank/Assault Weapon	Study; funds available in FY '63 budget
TOW (ARMY)	Martin, McDonnell, Hughes (feasibility studies)	Tube-launched, optically tracked, wire-guided antitank missile	Studies completed; no contracts awarded
CONDOR (NAVY)	No contracts announced	Air-to-surface missile for use with TFX aircraft	Study
WAGTAIL (AF)	Minneapolis-Honeywell, prime	Rearward-launched missile family for various aircraft applications, such as air-to-air and air-to-surface	Development

KDB-1 Target Drone (Navy); Model 1025 Cardinal (Army)

MISSION: Provides "out of sight" target for surface-to-air and air-to-air missiles

STATUS: Operational

PRIME CONTRACTOR: Beech Aircraft Corp.

PERFORMANCE: Max. speed—340 mph; Service ceiling—40,000 ft.; Endurance—60 min.

CONFIGURATION: Span—155 in.; Length—180 in.; Diameter (body)—17¾ in.; Weight—635 lbs.

GUIDANCE: Radio command

CONTROL SYSTEM: Two-axis Guidance Technology, Inc. gyroscope autopilot

PROPULSION SYSTEM: One McCullough turbo-supercharged, 125-hp engine

SUPPORT EQUIPMENT: Launched from zero-length launcher or aircraft; parachute-recovered

REMARKS: An advanced target drone with the same dimensions but enhanced performance has also been built by Beech. Designated the PD75-4-1, the only major difference between the two is that the PD 75 uses a 145-hp, four-cylinder Continental TS10-200 engine

KD2U-1 Target Drone (Army)

STATUS: Operational

PRIME CONTRACTOR: Ling-Temco-Vought Corp.

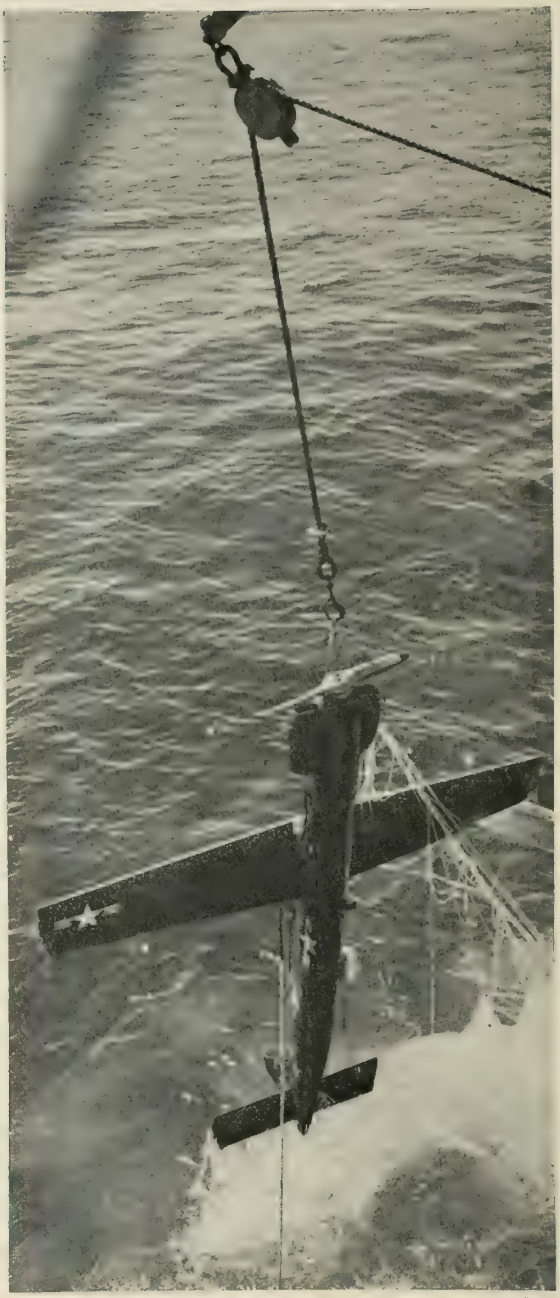
PERFORMANCE: Not available.

CONFIGURATION: Span—240 in.; Length—684 in.; Diameter (body)—72 in.

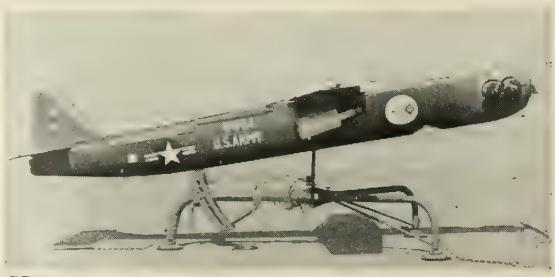
GUIDANCE: Not available.

PROPULSION SYSTEM: Booster—Aerojet 115,000-lb.-thrust solid-propellant motor. Sustainer—One General Electric J79 engine with afterburner

REMARKS: Target version of the Regulus II missile; limited production; flown as a target against air defense missile systems.



KD2R-5



SD-1

OQ-19E, Aerial Target (Army AF); KD2R-5 (Navy)

MISSION: Target for gunnery and missile training and evaluation

STATUS: Operational

PRIME CONTRACTOR: Northrop Ventura Div., Northrop Corp.

PERFORMANCE: Max. Speed—220 mph; Stalling speed—70 mph; Rate of climb—3350 fpm; Service ceiling—23,000 ft.; Endurance—60 min.

CONFIGURATION: Span—138.0 in. with pods 158.5 in.; Length—147.0 in.; Height—31.3 in. Total weight—326.8 lbs. with pods 353 lbs.

FLIGHT CONTROL: RPS-1A vhf command control system (OQ-19D); C-2A uhf proportional command control system with automatic stabilization (KD2R-5)

PROPULSION SYSTEM: 2-cycle, 4-cylinder, flat-opposed, air-cooled, McCulloch Motors engine, driving a fixed-pitch, 44-in.-dia. wooden propeller. Fuel capacity 11.3 gal.

PAYLOAD: For radar appearance augmentation two wing-tip reflector pods are added to OQ-19; standard on OQ-19D and KD2R-5

SUPPORT EQUIPMENT: OQ-19, ground- or air-launched; KD2R-5, ground-launched only; catapult, rotary or zero-length launchers used; single parachute 38-ft. dia. (OQ-19) or 32-ft. (KD2R-5) used for recovery

REMARKS: E model incorporates six-cylinder engine for increased performance; models still in use by Army and Air Force

Q-45, Target Drone (Air Force)

STATUS: Operational

PRIME CONTRACTOR: Northrop Ventura Div., Northrop Corp.

PERFORMANCE: Max Speed—Mach 2; Service Ceiling—70,000 ft.; Endurance—60 min.

CONFIGURATION: Span—156 in.; Length—432 in.; Max. weight—3350 lbs.

GUIDANCE: Radio command

PROPULSION SYSTEM: One General Electric J-85-5 Turbojet engine with 2450 lbs. thrust

SUPPORT EQUIPMENT: Launched from a carrier aircraft

REMARKS: Improved version of the Q-4A which used a Fairchild J-83 Turbojet engine; also being used by the Navy

Redhead-Roadrunner (Army)

MILITARY DESIGNATION: NA-273

MISSION: Supersonic target missile

STATUS: Development

PRIME CONTRACTOR: Columbus Div., North American Aviation, Inc.

PERFORMANCE: Max. speed—Mach 2; Service ceiling—over 50,000 ft.

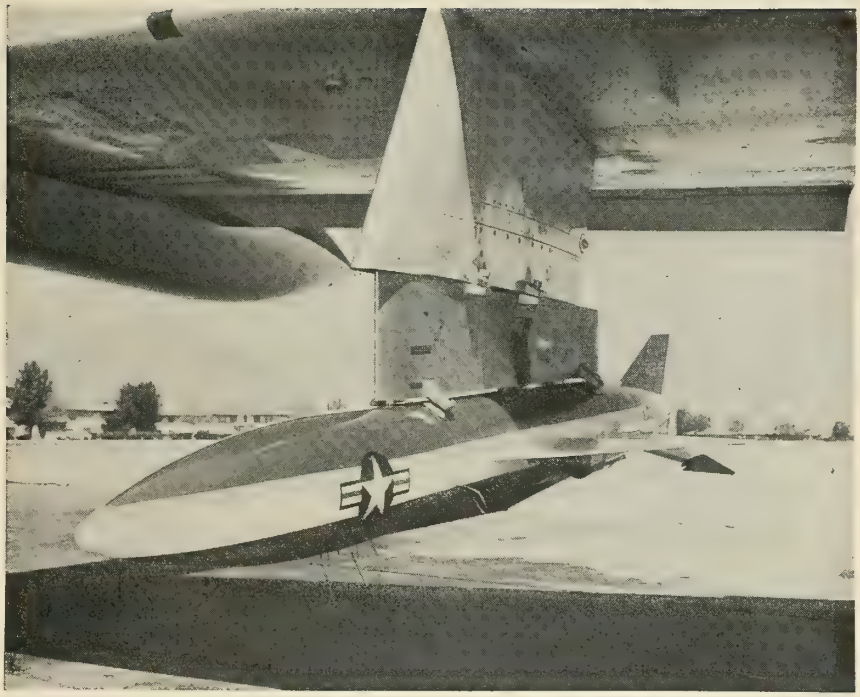
CONFIGURATION: Span—72 in.; Length—228 in.; Diameter (body)—12 in.; Weight—427 lbs.

GUIDANCE: System Contractor—NAA; Type—Radio command

PROPULSION SYSTEM: Booster: one 6000-lb.-thrust Rocketdyne solid motor; Sustainer; one Marquardt ramjet engine

SUPPORT EQUIPMENT: Parachute-recoverable

REMARKS: Designed for both low- and high-level missions; for low-level flights, the drone will be flown without the wings



RPT

Rocket Powered Target Drone Army/AF/Navy)

MILITARY DESIGNATION: RP-76 (Army); RP-78 (Air Force & Navy)

MISSION: Target for surface-to-air and air-to-air weapon systems tests and annual service practices

STATUS: Operational

PRIME CONTRACTOR: Northrop Ventura Div., Northrop Corp.

PERFORMANCE: Supersonic version: Max. speed—Mach 1.3; Service ceiling—75,000 ft.; Endurance—4 min. Subsonic version: Max. speed—Mach 0.9; Ceiling—61,800 ft.; Endurance—8 to 9 min.

CONFIGURATION: Span—60 in.; Length—116 in.; Height—18 in.; Max. weight—301 lbs.

INSTRUMENTATION: Six data channels on the tracking aid RF link for scoring

FLIGHT CONTROL: Automatic with command control override

PROPULSION SYSTEM: Solid-propellant rocket engine with twin thrust nozzles canted 15 degrees outboard in a horizontal plane

SUPPORT EQUIPMENT: Launched from a fighter-type aircraft; recovery by 3-ft. ribbon brake chute and 24-ft.-dia. main chute

REMARKS: Used extensively by the Army for annual service practices of Ajax, Hercules and Hawk units.

SD-1, Surveillance Drone (Army)

MISSION: Tactical, battlefield surveillance drone capable of performing remote-controlled photo and other sensory missions

STATUS: Operational

PRIME CONTRACTOR: Northrop Ventura Div., Northrop Corp.

PERFORMANCE: Max. speed—160 mph; Stalling speed—95 mph; rate of climb—1500 fpm; Service ceiling—15,000 ft.; Endurance—35 min.

CONFIGURATION: Span — 138.1 in.; Length—160.9 in.; Height—31.4 in.; Empty wt.—354.0 lbs.; Useful payload—88.0 lbs.; Total wt.—442.0 lbs.

FLIGHT CONTROL: Modified C-2A proportional-type command control system

TRACKING SYSTEM: AN/DPN-62 beacon (passive reflector pods optional) and an AN/MPQ-29 ground tracking system. Night lights for visual tracking

PROPULSION SYSTEM: Modified, four-cylinder, horizontally opposed, two-cycle, air-cooled engine (fuel capacity 5.6 gal.)

PAYLOAD: 88 lbs. of photographic and other sensory equipment

SUPPORT EQUIPMENT: Zero-length launcher; single-stage 44-ft. extended skirt recovery parachute

REMARKS: Only operational surveillance drone in the Army inventory; also being used by British troops

SD-2

MISSION: Tactical battlefield surveillance

STATUS: Production

PRIME CONTRACTOR: Aerojet-General Corp.

PERFORMANCE: Max. Speed—345 mph; Endurance—45 min.

CONFIGURATION: Span—156 in.; Length—192 in.; Launch Wt. (less boosters)—1103 lbs.

GUIDANCE: System contractor—ITT; Type—radio command

PROPULSION SYSTEM: System Contractor—Lycoming; Type—1 IMO-36OBIB, 225-hp engine; Drone also uses 2 JATO units for launch from its zero-length launcher

PAYLOAD: Photographic and other sensory equipment

SUPPORT EQUIPMENT: Launched from Army 2½-ton truck

REMARKS: Recently underwent tests at the Army Signal Corps test facilities at Yuma, Ariz.; SD-2XAE-1, a modified version of the SD-2, is capable of performing Chemical Corps missions

XKD2B.1 Target Drone (Navy); Q-12 (Air Force)

MISSION: Supersonic target drone designed for air-to-air and surface-to-air weapon system testing and training

STATUS: Development

PRIME CONTRACTOR: Beech Aircraft Corp.

PERFORMANCE: Max. speed—Mach 2; Service Ceiling—70,000 ft.

CONFIGURATION: Span—39 in.; Length—161 in.; Diameter (body)—13 in.; Weight—560 lbs. Frame—Swept delta wings with canard controls

CONTROL SYSTEM: Two-axis autopilot

PROPULSION SYSTEM: One Rocketdyne, liquid-propellant engine with 630 lbs. thrust

SUPPORT EQUIPMENT: Recoverable

FOREIGN



JINDIVIK MK. IIB

Australia

Malkara

TYPE: antitank and anti-bunker
MISSION: tactical
STATUS: operational
DEPLOYMENT: British Army
PRIME CONTRACTOR: Government Aircraft Factories (Australia)
PERFORMANCE: Range over 2 miles
CONFIGURATION: Length, 6½ ft. Span, 2 ft. 8 in. All-up weight, c. 200 lbs.
GUIDANCE: Wire
PROPULSION SYSTEM: Solid
PAYLOAD: 55 to 60 lbs.
REMARKS: Weapon was successful in 1961 tests against log-earth and log-stone bunkers

Aeolus

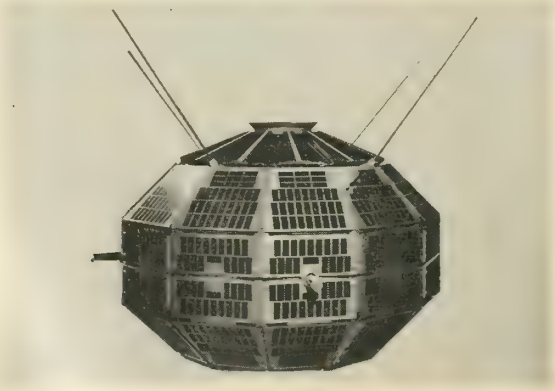
TYPE: Sounding rocket
STATUS: Operational
PRIME CONTRACTOR: Dept. of Supply
PERFORMANCE: Max. Alt., 250,000 ft.
CONFIGURATION: Two stage. All-up weight, 1270 lbs.
PROPULSION SYSTEM: Solid. First stage, cluster of seven
PAYLOAD: 30 to 130 lbs.

Long Tom

TYPE: Sounding rocket
STATUS: Operational
PRIME CONTRACTOR: Dept. of Supply
PERFORMANCE: Max. Alt., 600,000 ft. (180 lbs. payload to 300,000 ft., 50 lbs. to 500,000 ft.)
CONFIGURATION: Two-stage all-up weight, 2100 lbs.
INSTRUMENTATION: Weapons Research Establishment
PROPULSION SYSTEM: Solid. First stage, cluster of three

Jindivik Mk. IIB

TYPE: Drone
MISSION: Target
STATUS: Operational
DEPLOYMENT: Australia, U.K. and Sweden
PRIME CONTRACTOR: Government Aircraft Factory (Melbourne)
PERFORMANCE: Max. Alt., 60,000 ft. Near Mach 1. Range, 100 miles.
CONFIGURATION: Length, 23 ft. ¾ in; span, 25 ft. 7 in:
PROPULSION SYSTEM: Armstrong Siddeley Viper engine (ASV MK8 turbojet)
REMARKS: U.K. Ministry of Supply has export sales license agreement. Fairey Engineering Co., Ltd., is sales agent for export sales



ALOUETTE

Canada

Alouette

TYPE: Satellite
MISSION: Record galactic emissions, other investigations of communications data
STATUS: Near launch date
DEPLOYMENT: Joint U.S./Canada top-side sounder program
PRIME CONTRACTOR: Canadian Defense Research Telecommunications Establishment
CONFIGURATION: Girdle diameter, 42 in. Weight, 270 lbs. Antennas: one set, 75 ft.; one set, 37 ft.
REMARKS: Canada was first country to enter into joint U.S. space program formally. Alouette satellite is completely Canadian design and construction. Original launching by NASA from Vandenberg was to have been prior to April, 1962

Black Brant IVA

TYPE: Sounding rocket
MISSION: Research
STATUS: Development
PRIME CONTRACTOR: Bristol Aero-Industries Limited (Winnipeg)
PERFORMANCE: Max. Alt., 600 mi. Thrust: 1st stage, 24,500 lbs.; 2nd stage, 12,650 lbs.
CONFIGURATION: Two-stage. Length, 35.6 ft. Diameter, 17 in. and 10 in. All-up weight, 3144 lbs.
GUIDANCE: None
PROPULSION SYSTEM: Solid
PAYLOAD: 40 lbs. in 1.4 cu. ft.
REMARKS: Bristol Aero-Industries is principal contractor for versions III and V in Black Brant series. Early developers of the series through the IIA was CARDE (Canadian Armament Research and Development Establishment) who will continue propellant development. An early subcontractor under CARDE was Canadair for nose cone and fins

France

Agate

TYPE: IRBM test vehicle

MISSION: IRBM development and space research

STATUS: Operational

DEPLOYMENT: 1961

PRIME CONTRACTOR: S.E.R.E.B. and Sud-Aviation

SUBCONTRACTORS: Nord Aviation, S.E.P.R., Service des Poudres, Societe Anonyme de Telecommunications, S.F.E.N.A. and Iron-Fireman

PERFORMANCE: 6 successful launchings from mobile ramp at Hammaguir. Reached 30 mi. altitude with half-ton payload with instrumentation recovered

CONFIGURATION: Length, 27.8 ft.; Single stage; All-up weight, over 3 tons

GUIDANCE: None

PROPULSION SYSTEM: Solid; Weight of grain, 2 tons

PAYLOAD: Instrumentation

Antares

TYPE: IRBM development vehicle

MISSION: Re-entry tests

STATUS: Operational since 1960

PRIME CONTRACTOR: Office National d'Etudes et de Recherches Aeronautiques (O.N.E.R.A.)

PERFORMANCE: Re-entry speed under 4th-stage acceleration, Mach 8

CONFIGURATION: Four stages. Length, 40 ft.; 1st stage diameter, 22 in.; 4th stage diameter, 9 in.; All-up weight, 3900 lbs.

GUIDANCE: None

PROPULSION SYSTEM: Four solid stages. 1st and 3rd stages by S.E.P.R. 2nd stage by Fonderie de Ruelle (French Navy). All propellant by Service des Poudres

REMARKS: Flight tests conducted by Sud-Aviation on behalf of S.E.R.E.B.

AS. 20

TYPE: Air-to-surface

MISSION: Tactical

STATUS: Operational

DEPLOYMENT: NATO FIAT G.91 (Italy), most French jets

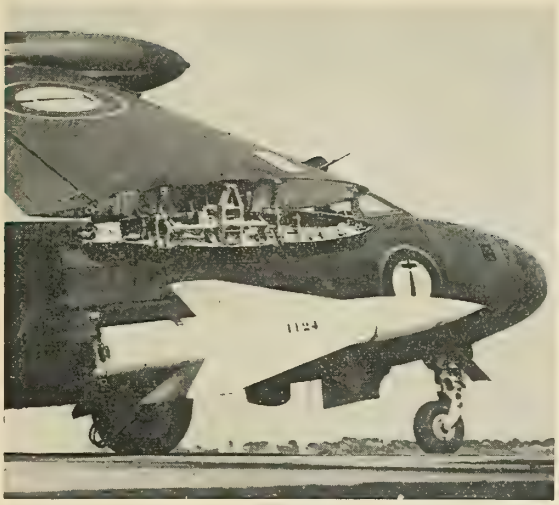
PRIME CONTRACTOR: Nord Aviation

CONFIGURATION: Length, 8½ ft.; Diameter, 9.84 in.; Span, 2½ ft.; All-up weight, 293 lbs.

GUIDANCE: Command with visual alignment

PROPULSION SYSTEM: Solid booster and solid sustainer

PAYLOAD: 50 lbs.



AS. 20



BERENICE

CT. 20



Berenice

TYPE: IRBM development vehicle

MISSION: Re-entry tests

STATUS: One flight test reported

PRIME CONTRACTOR: O.N.E.R.A. for S.E.R.E.B. (IRBM agency)

PERFORMANCE: Re-entry, Mach 12 with both 3rd and 4th stages fired in descent

CONFIGURATION: Four solid stages. Length, 42 ft.; Diameter: 1st stage, 22 in.; 4th stage, 9 in.; All-up weight, 7400 lbs.

GUIDANCE: First stage has 3-axis autopilot transmitting command signals to four solid boosters attached to first stage

PROPULSION SYSTEM: Four solid stages and four small solid boosters. All by S.E.P.R.

CT. 20

TYPE: Target drone

STATUS: Operational

PRIME CONTRACTOR: Nord Aviation

PERFORMANCE: Operates in 65-mi. radius; Speed, Mach .85 at 33,000 ft. for one hour; Max. alt., 45,000 ft.

CONFIGURATION: Length, 18½ ft.

PROPULSION SYSTEM: Turbomeca Marbore turbojet

Entac

TYPE: Antitank

MISSION: Tactical

STATUS: Operational

DEPLOYMENT: French Army. Being evaluated by U.S. and Belgium

PRIME CONTRACTOR: Direction des Etudes et Fabrications d'Armement (Army agency); First-line subcontractor: Atelier de Construction de Puteau; Second-line major manufacturer: Nord Aviation; Performance: Range; 1300 to 6600 ft.

CONFIGURATION: Length, 32 in.; Diameter, 17 in.; All-up weight, 26.4 lbs.

GUIDANCE: Wire

INSTRUMENTATION: 28.6 lbs. command equipment

AUXILIARY POWER: New primer battery gives long shelf life

PROPULSION SYSTEM: Solid

REMARKS: Over 10,000 units produced jointly by ACP and DEFA



MATRA R.530

STATALTEX



MASURCA



Malafon

TYPE: Ship-to-underwater
MISSION: ASW
STATUS: Operational
DEPLOYMENT: Command ship "La Galissoniere"
PRIME CONTRACTOR: Societe Industrielle d'Aviation Latecoere
PERFORMANCE: Range over 16,500 yds.
CONFIGURATION: Rocket-boosted homing torpedo
GUIDANCE: Programed. Torpedo has acoustical homing. Autopilot gives stabilization
INSTRUMENTATION: Sonar and computers shipboard
PROPULSION SYSTEM: Twin solid boosters
PAYLOAD: 220 lbs.

Masurca

TYPE: Ship-to-air
MISSION: Antiaircraft
STATUS: MK. I ready for deployment and installation
DEPLOYMENT: Frigate size ships generally. "Surcouf" class vessels cited as early users; also helicopter carrier "Jeanne d'Arc"
PRIME CONTRACTOR: Etablissement Industriel de la Marine Nationale a Ruelle (Charente Maritime)
PERFORMANCE: Range, 18 mi. at Mach 2.
CONFIGURATION: Length, 28.2 ft.; Weight, 3190 lbs.
GUIDANCE: Beam rider
PROPULSION SYSTEM: Solid booster and solid sustainer
REMARKS: MK. I is in limited production. MK. II is in flight testing.

Matra R.511

TYPE: Air-to-air
MISSION: Tactical
STATUS: Operational
DEPLOYMENT: Air Force and Navy aircraft
PRIME CONTRACTOR: Societe des Engins MATRA
CONFIGURATION: Length, 10.14 ft.; Diameter, 10 in.; All-up weight, 396 lbs.
GUIDANCE: Autopilot by Compagnie Francaise Thompson-Houston
PROPULSION SYSTEM: Solid by Hotchkiss-Brandt
PAYLOAD: HE

Matra R.530

TYPE: Air-to-air
MISSION: Tactical
STATUS: Final flight-testing. Production soon
DEPLOYMENT: Intended for Mirage III and other Air Force and Navy aircraft. Other countries evaluating system
PRIME CONTRACTOR: Societe des Engins MATRA
CONFIGURATION: Length, 11 ft.; Diameter, 10 in.; All-up weight, 429 lbs.
GUIDANCE: Electromagnetic by Generale Aeronautique Marcel Dassault. Infrared by Societe Anonyme de Telecommunications
PROPULSION SYSTEM: Solid fuel by Hotchkiss-Brandt
PAYLOAD: HE

Nord 5.401

MILITARY DESIGNATION: AS.30

TYPE: Air-to-surface

MISSION: Tactical

STATUS: Operational

DEPLOYMENT: Aircraft with 1220 lb. payload capability

PRIME CONTRACTOR: Nord Aviation

PERFORMANCE: Launched in level flight or dive

CONFIGURATION: Length 12.5 ft.; Diameter, 13½ in.; Span, 3.28 ft.; All-up weight, about 1100 lbs.

GUIDANCE: Multi-channel HF transmitter

PROPULSION SYSTEM: Solid booster and solid sustainer

REMARKS: Other NATO buyers have shown interest

SS-12, AS-12

TYPE: Antitank (air or surface launch)

MISSION: Tactical

STATUS: Test and evaluation

PRIME CONTRACTOR: Nord Aviation

PERFORMANCE: Surface launch max. range, 6550 yds.; Air launch max. range, 11,000 yds. (launch speed 325 knots)

CONFIGURATION: Length, 63 in.; Diameter, 7.1 in.; Span, 25.6 in.; All-up weight, 165 lbs.

GUIDANCE: Land: Wire. Air: radio

PROPULSION SYSTEM: Solid booster and solid sustainer

REMARKS: SS-12 and AS-12 air version are spin-stabilized

Stataltex

TYPE: Surface-to-air

MISSION: Antiaircraft prototype

STATUS: R&D

PRIME CONTRACTOR: Office National d'Etudes et de Recherches Aeronautiques

PERFORMANCE: Mach 5 plus in 1961 trials. Reached 125,000 ft. with lower Mach number. Booster gives Mach 3.2, sustainer ignites at 23,000 ft.

CONFIGURATION: Length, 17 ft.; Max. diameter, 16½ in.; All-up weight, 575 lbs.

GUIDANCE: None

INSTRUMENTATION: O.N.E.R.A. telemetering instrumentation.

PROPULSION SYSTEM: Ramjet sustainer. Solid S.E.P.R. booster

SUPPORT EQUIPMENT: Optical ground equipment employed at trials held at French Navy Launching Center (CERES) on Levant Island in Mediterranean

REMARKS: O.N.E.R.A. and Nord Aviation have an agreement for cooperation in the ramjet development field



VEGA



BELIER

CENTAURE



Vega

TYPE: Surface-to-air

MISSION: Antiaircraft prototype

STATUS: Development

PRIME CONTRACTOR: Nord Aviation

PERFORMANCE: Mach 4 in early trials. Operates between 65,000 and 110,000 ft. Booster, 5 secs. Booster provides Mach 2

CONFIGURATION: Length, 32.5 ft.; Diameter, booster 22 in.; sustainer 26 in.; Sustainer ramjet fueled weight, 1440 lbs.; Weight booster grain, 2340 lbs.

GUIDANCE: Autopilot

INSTRUMENTATION: O.N.E.R.A. telemetering equipment

PROPULSION SYSTEM: Solid booster using Vesuve-type propellant. Ramjet using 66 gals. (U.S. measure) kerosene. 4 in. increments add 3.2 gallons

PAYLOAD: 5-cu.-ft. compartment area. The 2.5-cu.-ft. rear compartment houses drag and main chutes

REMARKS: Nord has prime French ramjet development effort given by Direction Technique et Industrielle de l'Aeronautique (Defense Ministry agency)

Belier

TYPE: Sounding rocket

STATUS: Operational

PRIME CONTRACTOR: Sud-Aviation

PERFORMANCE: 4,070 lbs. thrust 22 secs.; spec. imp., 203 secs.; Max. alt., 62 miles; Max. vel., 4,330 f/s.

CONFIGURATION: Length, 13 ft.; Diameter, 11 in.; All-up weight, 689 lbs.

GUIDANCE: None

INSTRUMENTATION: Centre Nationale d'Etudes des Telecommunications

PROPULSION SYSTEM: Solid

PAYLOAD: 67 lbs.

REMARKS: Mobile launcher used in flight tests

Centaure

TYPE: Surface-to-air

MISSION: Research

STATUS: 10 units per month production

PRIME CONTRACTOR: Sud-Aviation

PERFORMANCE: Thrust: 1st stage, 8800 lbs. 4 secs.; 2nd stage, 4070 lbs. 22 secs.; Spec. Imp. 1st, 200 secs.; 2nd, 203 secs.; Max. alt., 125 mi.; Max. vel., 5834 f/s.

CONFIGURATION: Length, 19½ ft.; Diameter, 1st 9¾ in., 2nd 11 in.; All-up weight, 1080 lbs. max.

GUIDANCE: None

INSTRUMENTATION: C.N.E.T.

PROPULSION SYSTEM: Two solid stages

PAYLOAD: 70 to 135 lbs.

REMARKS: Mobile launcher used in flight tests

Diamond (French: Diamant)

TYPE: Space rocket

MISSION: Space research and IRBM development

STATUS: R&D (First stage will be fired this year. See Emerald rocket)

DEPLOYMENT: To be established by Centre National d'Etudes Spatiales (France's space agency)

PRIME CONTRACTOR: Societe d'-Etudes et de Realisation d'Engins Balistiques.

PERFORMANCE: Up to three versions are reported to be in R&D. First satellite according to current schedule will weigh 176 lbs. Perigee, 250 miles. Apogee, 780 miles. Inclination, 30°

CONFIGURATION: Three stages; First: liquid; 2nd and 3rd, solid; Length, 52.8 ft.; All-up weight estimated at near 17 tons

GUIDANCE: Inertial

PROPULSION SYSTEM: First stage possibly by Nord Aviation and second stage possibly by Sud-Aviation

REMARKS: Diamond is the third of France's "precious stone" series of large rocket development

Dragon

TYPE: Surface-to-air

MISSION: Research

STATUS: Flight tests imminent.

PRODUCTION: 4 units/mo.

PRIME CONTRACTOR: Sud-Aviation

PERFORMANCE: Thrust: 1st 24,000 lbs. 16½ secs.; 2nd 4070 lbs. 22 secs.; Spec. imp., 1st 250 secs.; 2nd 203 secs.; Max. alt., 365 mi.; Max. vel., 10,660 f/s.

CONFIGURATION: Length, 23 ft.; Diameter: 1st 2.8 ft.; 2nd 11 in.; All-up weight, max. 2926 lbs.

GUIDANCE: None

INSTRUMENTATION: C.N.E.T.

PROPULSION SYSTEM: Solid

PAYLOAD: 70 to 440 lbs.

REMARKS: Operational date: December, 1962

Emerald (French: Emeraude)

TYPE: Space rocket

MISSION: Space research

STATUS: First flight test imminent

DEPLOYMENT: Evaluating propulsion, design and airframe characteristics for "precious stones" series of space rocket program

PRIME CONTRACTOR: Societe d'-Etudes et de Realisation d'Engins Balistiques (S.E.R.E.B. is France's IRBM agency)

MAJOR SUBCONTRACTOR: Nord Aviation

CONFIGURATION: Length, 54.3 ft.; Liquid first stage, dummy second and third stages

GUIDANCE: None

PROPULSION SYSTEM: Liquid

REMARKS: Emerald is the flight-test program to establish the characteristics of Diamond

Eridan

TYPE: Surface-to-air

MISSION: Research

STATUS: R&D

PRIME CONTRACTOR: Sud-Aviation

PERFORMANCE: Thrust: 22,000 lbs. ea. stage for 15 secs.

CONFIGURATION: About 26 ft. max. length. Total weight about 4400 lbs.

PROPULSION SYSTEM: Solid

PAYLOAD: Up to 660 lbs.

Sapphire (French: Saphir)

TYPE: Space rocket

MISSION: Space research and IRBM development

STATUS: Sapphire I and II reported to be in R&D

DEPLOYMENT: mid-1963

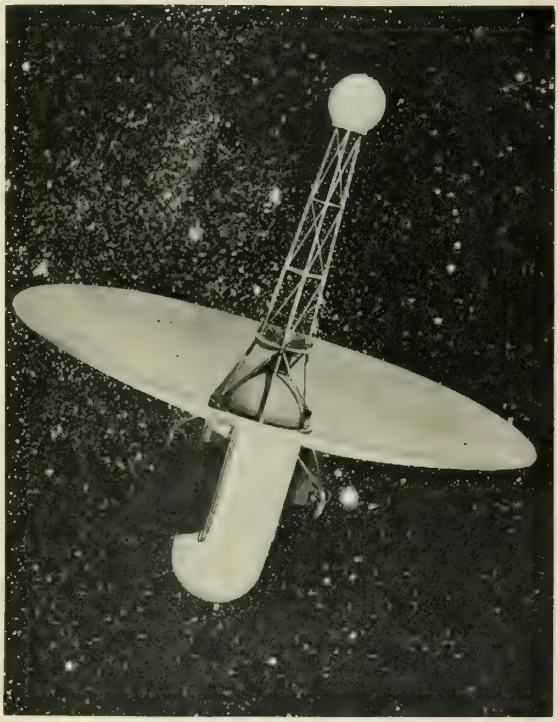
PRIME CONTRACTOR: S.E.R.E.B.

MAJOR SUBCONTRACTORS: Nord Aviation and Sud-Aviation

CONFIGURATION: Length, 54.3 ft.; Liquid first stage, solid second stage which, according to "France-Soir," has "four movable nozzles." Dummy third stage.

GUIDANCE: Inertial

REMARKS: Second in "precious stone" series



PHAETON

Phaeton

TYPE: Satellite

MISSION: Magnetism and radiation measurements. Eventually radio transmission

STATUS: R&D

PRIME CONTRACTOR: Societe d'-Etude de la Propulsion par Reaction

PERFORMANCE: Thermic-electrical propulsion, 20 g's. (Subsequent design goal may be 40 g's)

CONFIGURATION: Length from boiler (top) to reservoir (bottom), 16.4 ft.; Diameter of parabolic reflector, 15.7 ft.; All-up weight varies from 660 lbs. to 2420 lbs.

GUIDANCE: None

AUXILIARY POWER: Self-generating 2.25 kw

PROPULSION SYSTEM: Liquid hydrogen. 3000K during orbiting

PAYLOAD: Unknown but trade off between max. instrumentation and max. fuel carrying equals 250 lbs.

REMARKS: Unlikely candidate for first all-French satellite effort because of weight, despite first acknowledged laboratory-developed satellite design and construction in Europe. (See Diamond rocket)

Germany

Cobra (Germany)

TYPE: Antitank

STATUS: Operational

PRIME CONTRACTOR: Boelkow Entwicklungen, Munich

PERFORMANCE: Range—5940 ft. (max.), 5280 ft. (effective); Speed 180 mph

FRAME: System Contractor—Boelkow; Length—30.7 in.; Diameter—3.9 in.; Height—13.6 in.; Span—19 in.; Weight—20.2 lbs.

GUIDANCE: System contractor—Boelkow; Type—Wire

PROPULSION SYSTEM: System contractor—Oerlikon; Propellant—Solid

PAYLOAD: Armor-piercing warhead; Weight—5.5 lbs.

REMARKS: Missile is launched and guided to its target by one man; Marines evaluated the missile for U.S. use

Israel

Meteor II (Shavit Shtayem)

TYPE: Surface-to-surface and surface-to-air

MISSION: Research

STATUS: R&D

PRIME CONTRACTOR: Believed to be Haifa Technion (Aeronautical Dept.)

PERFORMANCE: First public launching reached 48 mile altitude

CONFIGURATION: Total weight given as between 550 and 660 lbs.

GUIDANCE: None

Italy

Meteo I

TYPE: Sounding rocket

MISSION: Research

STATUS: Testing

PRIME CONTRACTOR: Bombrini Parodi-Delfino

PERFORMANCE: 12-lb. payload to 43 mi.

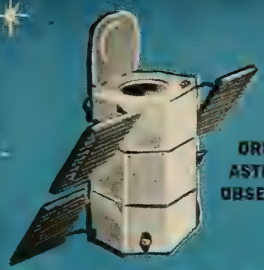
CONFIGURATION: Two-stage; Length, about 8 ft.; Diameter, about 10 in.

GUIDANCE: None

PROPULSION SYSTEM: Solid

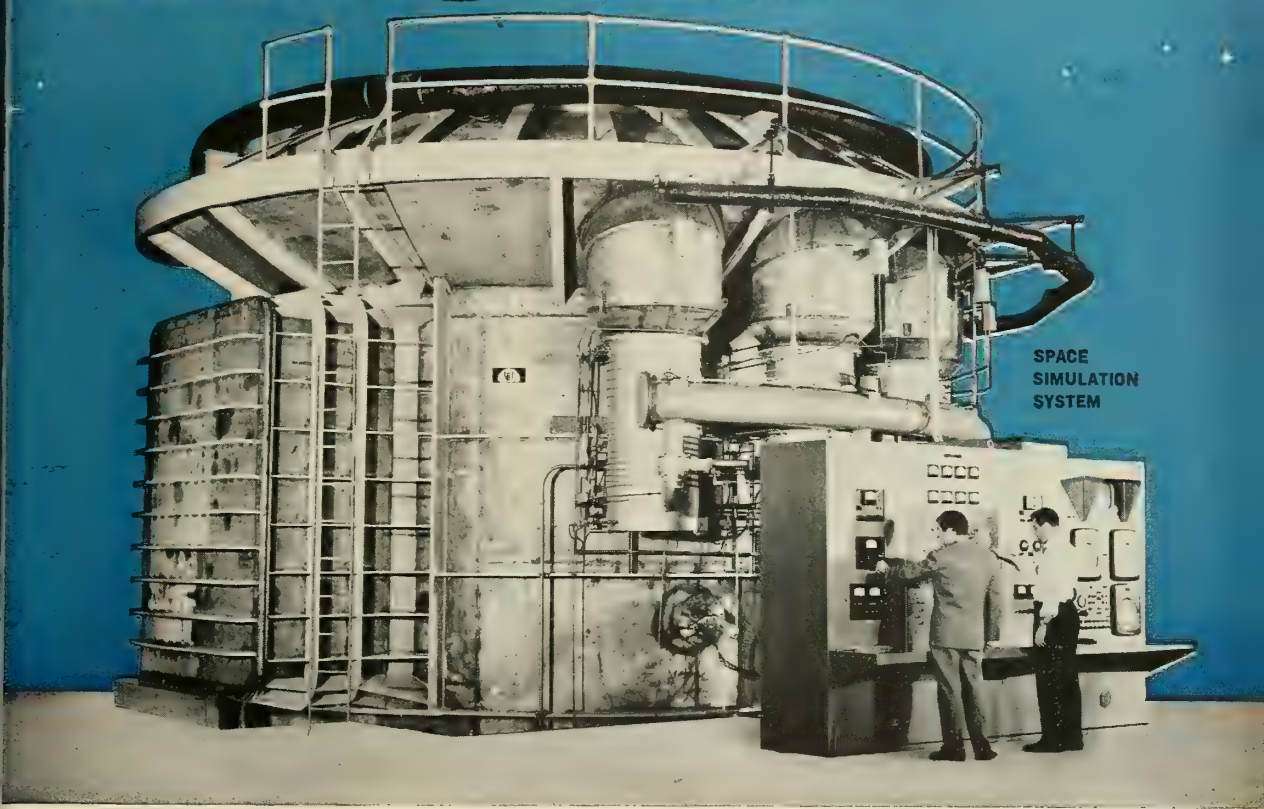
REMARKS: Longer versions are Meteo II and Meteo III. Max. diameter of Mk. III version will be about 21 in. Follow-on versions are in R&D. Anticipated max. alts. are 62 mi. and 95 mi. respectively, each carrying 25-lb. payloads

(Continued on page 105)



344 miles accomplished!

To Simulate 200 miles up... at Grumman



CB-624

...temperatures from +350°F to -320°F

6.5×10⁻⁹ accomplished! ...vacuum to 1 x 10⁻⁷ mm Hg

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FROM DELCO RADIO

That's the big feature in Delco Radio's new 175 VA and 250 VA static inverter power supplies. These *all-transistor* units offer increased reliability through simplified circuits. Both static inverters are designed for either airborne or ground applications and will withstand overload and output short circuit conditions indefinitely, delivering at least 110% of rated output before going into overload protection. Units automatically recover to full output upon removal of overload and short circuit. Units are designed to meet the environmental requirements of MIL-E-5272C. For further information on military electronics write Delco Radio's Military Sales Department.





ELECTRICAL SPECIFICATIONS

175 VA STATIC INVERTER

Input
Voltage: 27.5 VDC ± 10% per MIL-STD-704

Output

Power:	175 VA single phase 0.5 lag to 1.0 power factor
Voltage:	115 V adjustable from 110 to 120 volts
Regulation:	1-volt change for any variation of load between zero and 110% of full load, and input voltage between 25 VDC and 30 VDC
Frequency:	400 ± 1 cps. Frequency changes less than 1.0 cps. for all environment, load and input voltage variation
Distortion:	Less than 5% total harmonic
Efficiency:	80% at full load

250 VA STATIC INVERTER

Input
Voltage: 27.5 VDC ± 10% per MIL-STD-704

Output

Power:	250 VA single phase 0.6 lag to 1.0 power factor
Voltage:	115 V adjustable from 110 to 120 volts
Regulation:	0.7 volt for any variation of load between zero and 110% of full load, and input voltage between 25 VDC and 30 VDC
Frequency:	400 ± .5 cps. Frequency changes less than 1.0 cps. for all environment, load and input voltage variation
Distortion:	Less than 5% total harmonic
Efficiency:	80% at full load

DELCO RADIO
DEPENDABILITY
RELIABILITY
Division of General Motors • Kokomo, Indiana

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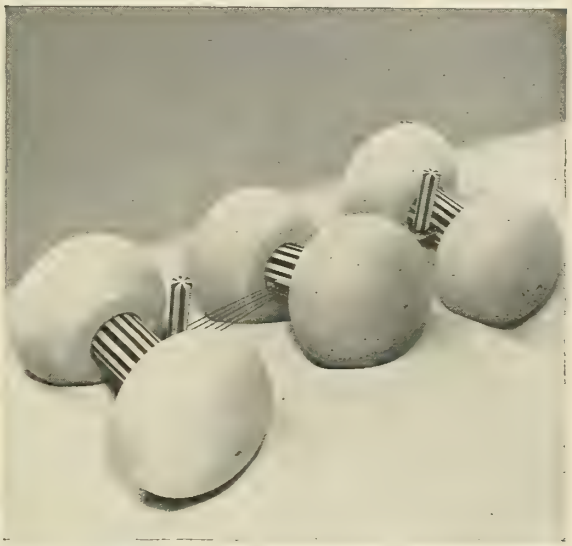
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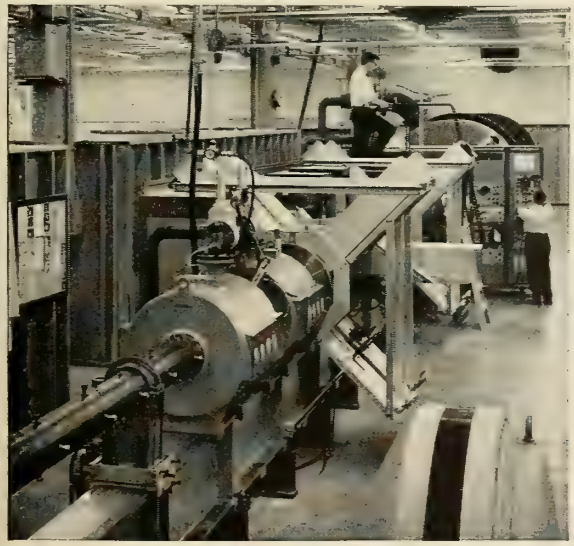


SEA OPERATIONS: Today, top-flight scientists at GM/DRL are at work in, on, and under the sea, prying out the ocean's secrets. From their studies can come detailed knowledge pointing the way to more precise methods of underwater tracking, navigation, undersea charting and marine vehicle mobility.



LAND OPERATIONS: All scientific knowledge is utilized in GM/DRL's search for more effective systems operating in the surface environment. Research into terra-mechanics, articulated vehicles, and electronics is resulting in new systems for tactical warfare and lunar and planetary exploration.

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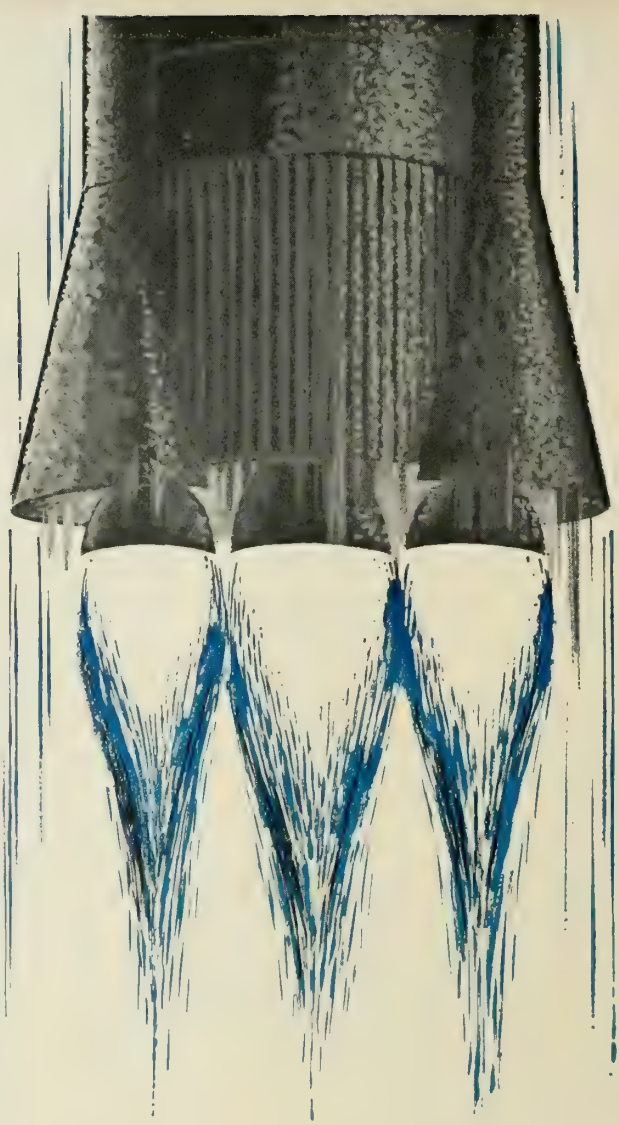
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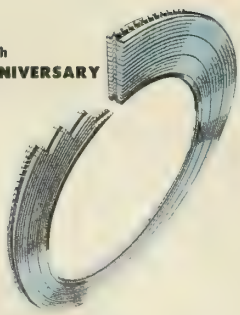
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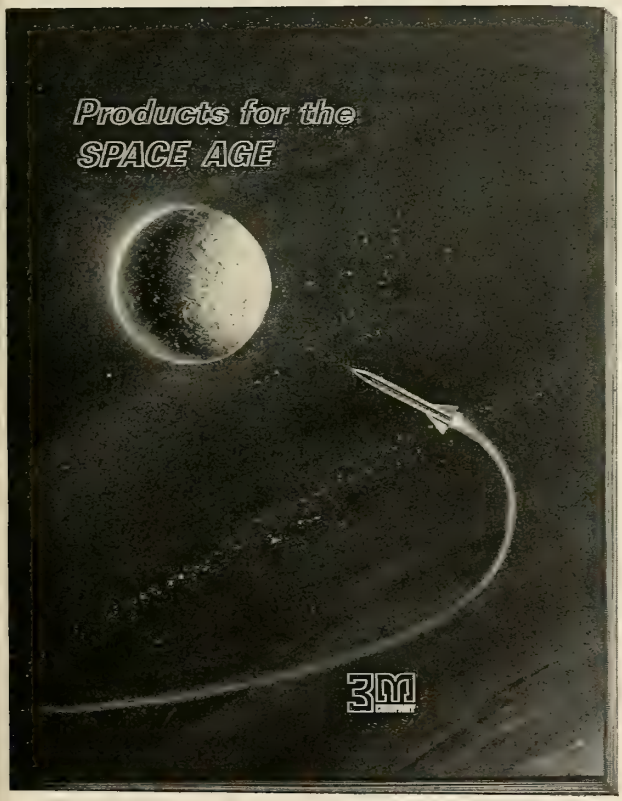
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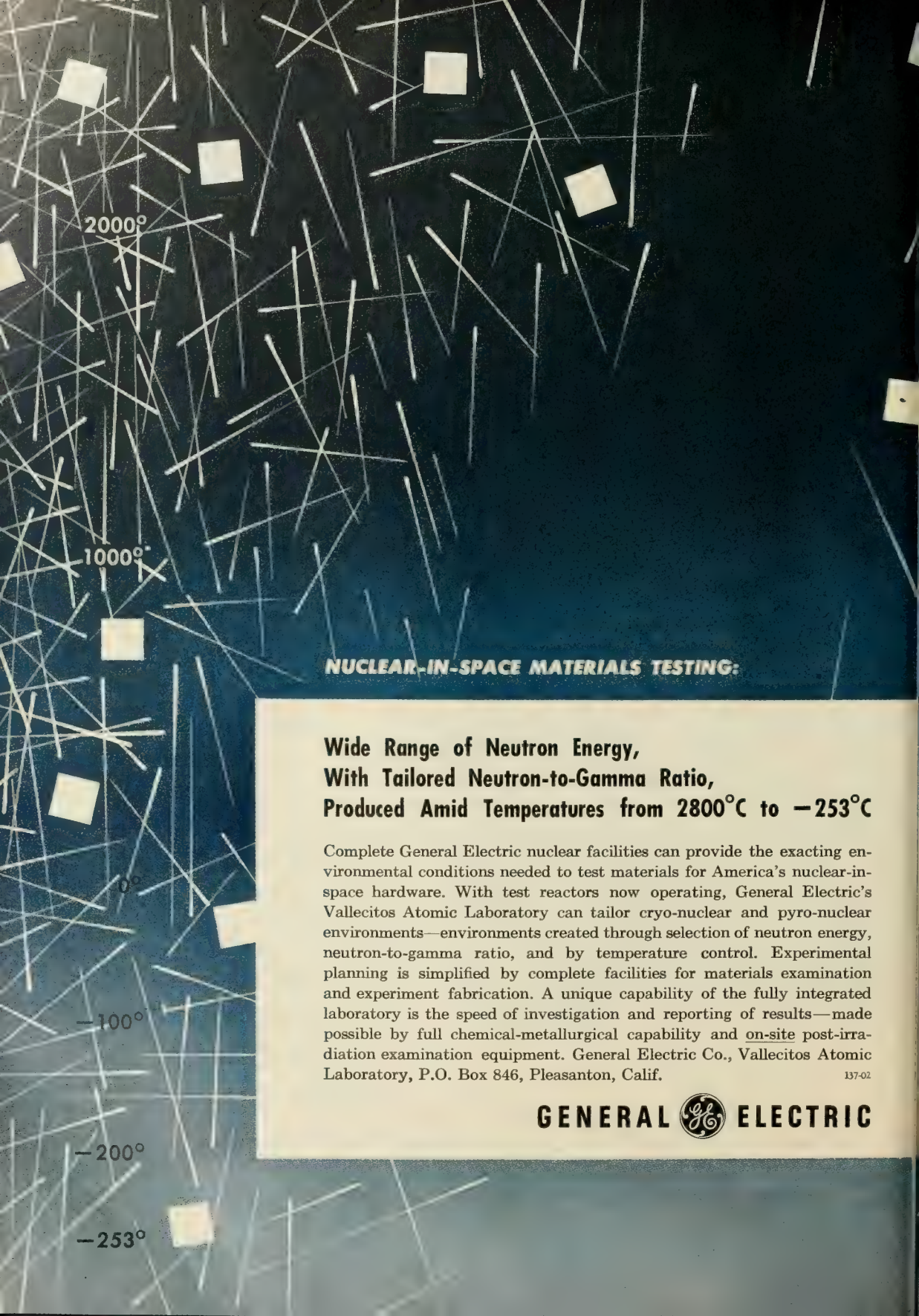
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GENERAL ELECTRIC

(Continued from page 96)

Meteor P.2

TYPE: Surveillance drone

MISSION: TV reconnaissance

STATUS: Operational

PRIME CONTRACTOR: Meteor, S.p.A.

CONFIGURATION: Length, 14 ft. 5 in.; Span, 12 ft. 2 in.; All-up weight, 930 lbs.

C-7

TYPE: Air-to-air

MISSION: Tactical

STATUS: Flight testing and evaluation

DEPLOYMENT: Italian Air Force

PRIME CONTRACTOR: Societa Italiana Sviluppo Propulsione a Reazione

CONFIGURATION: Length, 6½ ft. Diameter, 6 in. All-up weight, 155 lbs.

GUIDANCE: Infrared

PROPULSION SYSTEM: Solid by Thiokol. Final production model will have Bombrini Parodi-Delfino rocket motors, also solid

REMARKS: Alternate radar guidance may be incorporated by SISPRE

Japan

Lambda 3S

TYPE: Surface-to-air

MISSION: Research

STATUS: Near operational

DEPLOYMENT: National Space Activities Council

PRIME CONTRACTOR: Institute of Industrial Science, University of Tokyo. Subcontractors: Radio Research Laboratories, Yokogawa-Electric Co., Ltd., Riken Institute

PERFORMANCE: Max. alt., 1000 mi. (80° launch angle) with 22-lb. payload. Max. vel., 15,744 f/s. First-stage thrust, 42 tons.

CONFIGURATION: Three stages; Length, 59 ft.; Diameter, 28 in.; First stage has four nozzles

GUIDANCE: None

INSTRUMENTATION: Nippon-Electric Co., Ltd. and Meisei-Electric Co., Ltd.

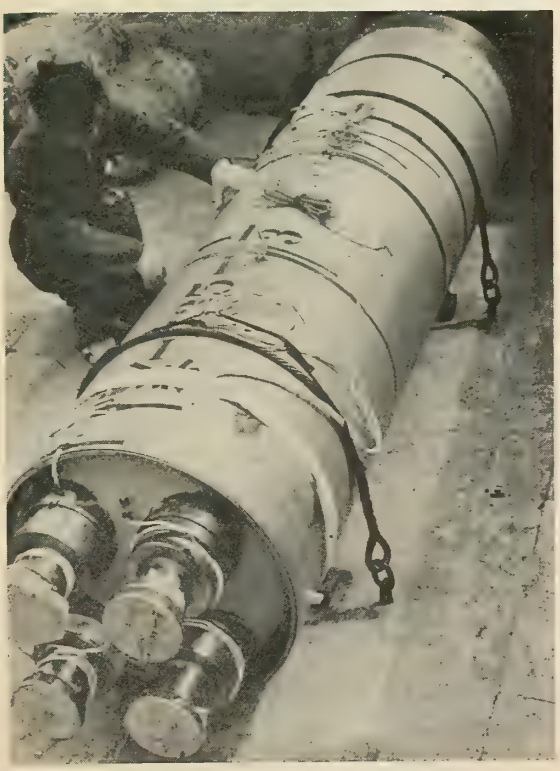
PROPULSION SYSTEM: Solid. Fuji-Precision-Machinery Co., Ltd.

PAYLOAD: Lambda series: Mk. 1, 1100 lbs.; Mk. 2, 220 lbs.; Mk. 3, 120 lbs.; Mk. 4, 22 lbs. At 80° launch, max. alts. for Mks. 1, 2 and 3 are 48 miles, 204 miles and 310 miles

REMARKS: Mobile launcher used. Japanese space efforts outgrew early Akita Rocket Range on Sea of Japan. Lambda and Mu series of rockets will be launched from new Pacific site on SE corner of Kyushu Island at Uchinoura, where the Kagoshima Space Center has been dedicated



METEO I



LAMBDA (1/3 SCALE)

Mat I

TYPE: Antitank

MISSION: Tactical

STATUS: Development

DEPLOYMENT: Japan Army Self Defense Forces, J.D.A.

PRIME CONTRACTOR: Kawasaki Aircraft Co., Ltd. (Gifu Seisakusho)

PERFORMANCE: Max. range reported as 5000 ft.

GUIDANCE: Wire

PROPULSION SYSTEM: Solid

REMARKS: First reported firing, March, 1961. Subcontractors to Kawasaki have been reported to be Nippon Electric, Nippon Grease and Oil, and Dai Nippon Celluloid (in first public showing in a Tokyo parade, MAT missiles were jeep-mounted)

Netherlands

At-21

TYPE: Target

MISSION: Naval gunnery drill

STATUS: Development

PRIME CONTRACTOR: Aviolanda Maatschappij Voor Vlietuigbouw

PERFORMANCE: Alt., 9500 ft.; Flight time, 67 min.; climbs to 5000 ft. in 30 secs.; Sustained speed, 225 mph.; Recovered by parachutes over water

AUXILIARY POWER: Solid boosters by S.E.P.R. (France)

PROPULSION SYSTEM: Jet engine

CONFIGURATION: Length, 43.2 in. Sliding fins for Mach 1 a/c. Folding fins for faster aircraft

PROPULSION SYESTEM: Solid

REMARKS: New MK 12 NATO launcher matched by HS. Other company rocket is the Lesca in 10 to 40 tube units. Max. Lesca ground range 10,350 yds.

Norway

Terne III

TYPE: Ship-to-underwater

MISSION: ASW

STATUS: Operational

DEPLOYMENT: Aboard Norwegian naval ships. U.S. evaluating

PRIME CONTRACTOR: Kongsberg Vapenfabrikk

PERFORMANCE: Range—more than 3.5 miles

CONFIGURATION: Length, 6.5 ft.; Diameter, 7.9 in.

GUIDANCE: None

FIRE CONTROL: Sonar, computers and movable ramp

PROPULSION SYSTEM: Solid

PAYLOAD: Mk 7

REMARKS: Can fire 6 missiles in 5 secs.

Sweden

Bantam

TYPE: Antitank

MISSION: Tactical

STATUS: Operational

PRIME CONTRACTOR: AB Bofors

PERFORMANCE: Max. range, 2200 yds.; Vel., 280 f/s; Temp. range, −40°C to +60°C

CONFIGURATION: Length, 33 in.; Diameter, 4.3 in.; Span (unfolded), 16 in.; Missile container: 37x7x7 in.; Weight of container and missile: 24 lbs.

GUIDANCE: Wire; Four Tracers; Gyro-stabilized; Line-of-sight command

PROPULSION SYSTEM: Solid fuel

REMARKS: Effective range covers 100° of field of view with minimum range at 0° possible to execute at 3½ secs.

Erika

TYPE: Ship-to-underwater

MISSION: ASW

STATUS: Evaluation

PRIME CONTRACTOR: AB Bofors

Frida, Gerda, Adam

TYPE: Air-to-air (Adam is air-to-surface)

MISSION: Tactical

STATUS: Operational

DEPLOYMENT: Swedish Saab, Lansen and Draken aircraft

PRIME CONTRACTOR: AB Bofors

PERFORMANCE: Frida has 2624 f/s vel. at 32,000-ft. alt. with 9 secs. burning. Gerda is an improved air-to-air system. Adam has 2130 f/s vel., warhead weighs 39.7 lbs.; all-up weight, 90.4 lbs. 50% radial dispersion is about 4 mils

FIRE CONTROL: Svenska Aeroplane AB (SAAB)

PROPULSION SYSTEM: Solid



ROBOT 304



BANTAM CONTAINER



ROBOT 315

Robot 304

TYPE: Air-to-surface

MISSION: Tactical

STATUS: Operational

DEPLOYMENT: Swedish Air Force

PRIME CONTRACTOR: Swedish Guided Missile Bureau and Royal Swedish Armed Forces Research Establishment

CONFIGURATION: Length, 14.76 ft.; Span, 6.4 ft.

GUIDANCE: Radio command

PROPULSION SYSTEM: Solid

Robot 315

TYPE: Ship-to-surface

MISSION: Tactical

STATUS: Operational

DEPLOYMENT: Swedish naval destroyers

PRIME CONTRACTOR: Swedish Guided Missile Bureau and Royal Swedish Armed Forces Research Establishment

CONFIGURATION: Length, 24 ft.

PROPULSION SYSTEM: Solid booster and solid sustainer

Switzerland

Sura 8-80

TYPE: Surface-to-air

MISSION: Troop support, tactical

STATUS: Operational

PRIME CONTRACTOR: Hispano-Suiza (Suisse) S.A.

PERFORMANCE: Thrust, 2640 lbs. In volley tests from aircraft at 497 mph, 50% dispersion was 10 milliradians

RSD-"X"

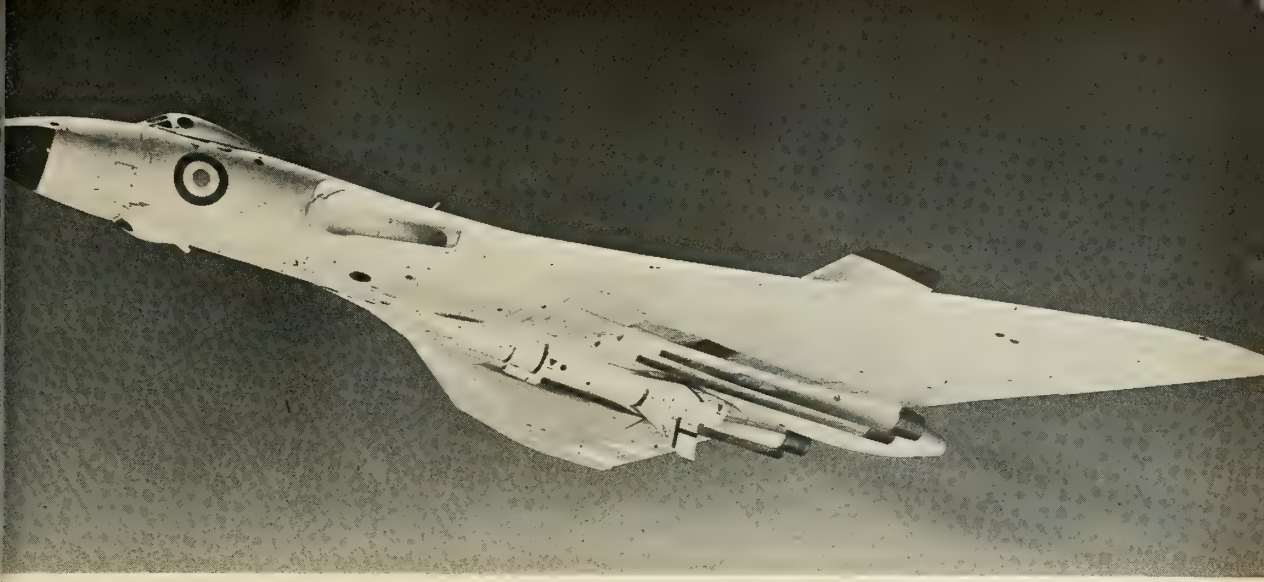
TYPE: Surface-to-air

MISSION: Antiaircraft

STATUS: R&D

PRIME CONTRACTOR: Contraves AG

REMARKS: The new Swiss missile "X" is a Government project following earlier RSA-54, RSC-57 and RSD-58, which saw service for training purposes in Switzerland, Italy and Japan. Subcontractors for the RSD-58 included Oerlikon Machine Tool Works, Buhrle & Co. and Brown, Boveri & Co.



BLUE STEEL ON VULCAN

United Kingdom

Bloodhound

TYPE: Surface-to-air

MISSION: Antiaircraft defense, particularly around airbases

STATUS: Operational

DEPLOYMENT: RAF. Sweden has purchased system. Australia has deployed units

PRIME CONTRACTOR: Bristol Aircraft Limited (BAC)

GUIDANCE: Ferranti, Ltd.

GROUND EQUIPMENT: Pulsed illuminating radar by Associated Electrical Industries

FIRE CONTROL: Digital

PROPULSION SYSTEM: Four solid boosters with two ramjet sustainers by Bristol Siddeley

SUPPORT EQUIPMENT: Early-warning radar, control radar (tactical control)

Bloodhound II

TYPE: Surface-to-air

MISSION: Antiaircraft

STATUS: Development

DEPLOYMENT: Eventually to RAF. Switzerland will adopt system

PRIME CONTRACTOR: Bristol Aircraft Limited (BAC)

PERFORMANCE: Increased flexibility against low-altitude aircraft and extended range of action. Ceiling, 60,000 ft. Range, 70,000 yds.

GUIDANCE: Ferranti, Ltd.

GROUND EQUIPMENT: Continuous-wave radar

PROPULSION SYSTEM: Improved ramjets by Bristol Siddeley

Blue Steel

TYPE: Air-to-surface

MISSION: Strategic

STATUS: Production

DEPLOYMENT: RAF V Bombers

PRIME CONTRACTOR: A. V. Roe & Co., Ltd. (Hawker Siddeley Group)

CONFIGURATION: Length 35 ft.; Span 13 ft.

GUIDANCE: Intertial: Elliott Brothers

PROPULSION SYSTEM: Liquid; Bristol Siddeley Fuel: Kerosene with hydrogen peroxide



BLOODHOUND I

Blue Streak

TYPE: Space rocket first stage

MISSION: European space program

STATUS: Development

DEPLOYMENT: European Satellite Launching Organization

PRIME CONTRACTOR: De Havilland Propellers Ltd.

PERFORMANCE: Surface thrust, 137,000 lbs.

PROPULSION SYSTEM: Liquid, Rolls-Royce Limited. LOX by British Oxygen Gases Ltd.

REMARKS: French second stage and West German third stage will give this ESLO satellite rocket an overall height of about 99½ ft. First satellite launch expected in 1967. Rockets will be purchased by ESRO (European Space Research Organization) whose ten members adopted an eight-year $300,000,000 budget on June 14, 1962.

Blue Water

TYPE: Surfact-to-surface

MISSION: Tactical

STATUS: Development and flight-testing

PRIME CONTRACTOR: English Electric Aviation Ltd. (BAC)

PERFORMANCE: Maximum range, over 70 mi.

CONFIGURATION: Length, 27 ft.; body diameter, 2 ft.; wing span, 6 ft. 9 in.; fin span, 6 ft. 5 in.

GUIDANCE: Intertial

FIRE CONTROL: Mobile van computer

PROPULSION SYSTEM: Solid, single-stage, no booster

PAYLOAD: HE or nuclear

SUPPORT EQUIPMENT: Theodolite

REMARKS: Mobile land system requires two vehicles—one the launcher carrying the missile, the second carrying the computer. Air-portable in AW 660-type aircraft

Firestreak

TYPE: Air-to-air
MISSION: Tactical
STATUS: Operational
DEPLOYMENT: RAF and RN (Javelin, Lightning and Sea Vixen)
PRIME CONTRACTOR: De Havilland Aircraft Company Ltd.
CONFIGURATION: Length, 10½ ft. Diameter 8.67 in. Wingspan, 29.4 in. All-up weight, 300 lbs.
GUIDANCE: Passive infrared
PROPULSION SYSTEM: Solid

Red Top

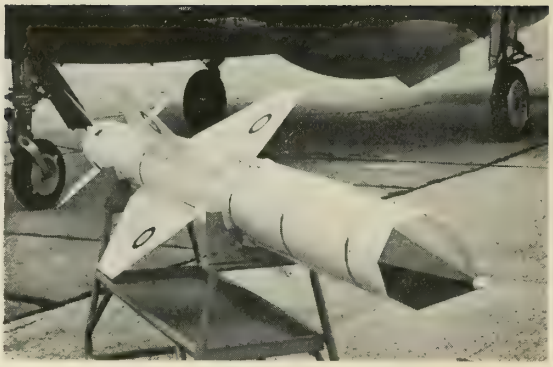
TYPE: Air-to-air
MISSION: Tactical
STATUS: R&D
PRIME CONTRACTOR: De Havilland Aircraft Company Ltd.
GUIDANCE: Infrared
REMARKS: Destined for deployment on Lightning aircraft

Seacat

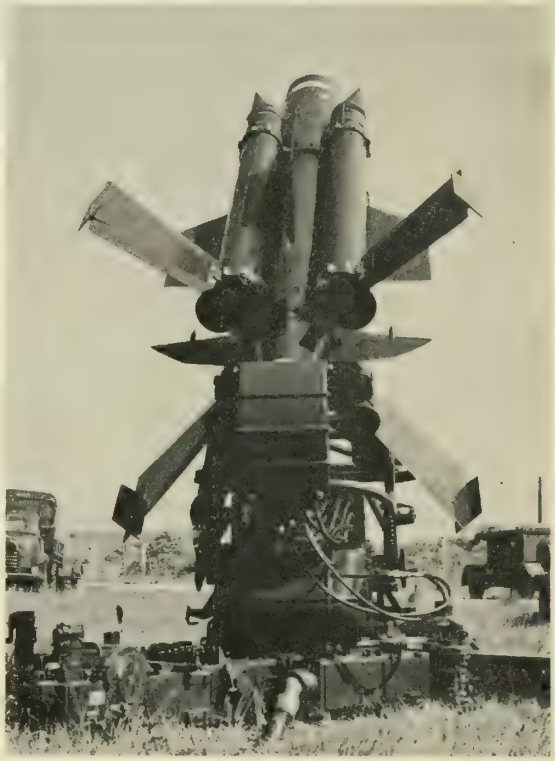
TYPE: Ship-to-air
MISSION: Antiaircraft
STATUS: Production
DEPLOYMENT: Royal Navy. Ordered by West German, Swedish, Australian and New Zealand navies
PRIME CONTRACTORS: Short Brothers & Harland Ltd.
PERFORMANCE: Short-range defense
CONFIGURATION: Length, 58 in. Diameter 7½ in.
GUIDANCE: Infrared scanning and radio command
PROPULSION SYSTEM: Solid booster and sustainer
LAUNCHER: Quadruple launcher manufactured by Rose Brothers
REMARKS: Agreement made with Focke-Wulf for maintenance of Seacat systems on ships berthing in West German ports

Seaslug I

TYPE: Ship-to-air
MISSION: Antiaircraft
STATUS: Operational
DEPLOYMENT: Royal Navy
PRIME CONTRACTOR: Whitworth Gloster Aircraft Ltd.
PERFORMANCE: Long-range
CONFIGURATION: Length, 19.5 ft. Diameter, 1.5 ft. Wingspan, 4.5 ft.
GUIDANCE: Beam-riding, by The General Electric Co., Ltd.
PROPULSION SYSTEM: Four solid boosters and solid sustainer
FLIGHT CONTROLS: Sperry Gyroscope Co., Ltd.
PAYLOAD: HE



RED TOP



THUNDERBIRD I



VIGILANT

Seaslug II

TYPE: Ship-to-air
MISSION: Antiaircraft
STATUS: R&D
PRIME CONTRACTOR: Whitworth Gloster Aircraft Ltd.
PERFORMANCE: Greater range and speed than Mark I version

Thunderbird I

TYPE: Surface-to-air
MISSION: Antiaircraft
STATUS: Operational
DEPLOYMENT: British Army in U.K. and in West Germany
PRIME CONTRACTOR: English Electric Aviation Ltd. (BAC)
CONFIGURATION: Length, 20 ft. 8 in.; Body diameter, 1 ft. 8¾ in.; Wing span, 5 ft. 4 in.
GUIDANCE: Semi-active pulse radar
PROPULSION SYSTEM: Four solid boosters and one solid sustainer
PAYLOAD: HE or nuclear
REMARKS: Mobile

Thunderbird II

TYPE: Surface-to-air
MISSION: Antiaircraft
STATUS: Evaluation trials
PRIME CONTRACTOR: English Electric Aviation Ltd. (BAC)
GUIDANCE: Continuous-wave radar

Vigilant

TYPE: Antitank
MISSION: Tactical
STATUS: Operational in British Army. On order to undisclosed foreign buyers
DEPLOYMENT: Individual combat troops
PRIME CONTRACTOR: English Electric Aviation Ltd. (BAC)
PERFORMANCE: Max. speed, 510 fps.; Range: 250 to 1800 yds.
CONFIGURATION: Weight, 32 lbs. Four cruciform wings.
GUIDANCE: Command-visual line of sight-wire control. Thumb controller sends d-c signals for pitch and yaw channels. Also has autopilot
PROPULSION SYSTEM: Two-stage; solid
PAYLOAD: 131mm shaped charge
REMARKS: While effective for one-man use, it can be mounted on combat vehicles and dropped by parachute in airborne operations. Designed and developed by Vickers Armstrongs (Aircraft) Ltd., also a BAC member

SOVIET UNION

Space Systems

Cosmos I-VI

TYPE: Space research satellites
MISSION: Check and improve "elements of space vehicle construction," study "the effect of meteoric matter on the construction elements of space vehicles" and study ionospheric concentration of charged particles, solar corpuscular flows and low-energy particles, cosmic rays, Van Allen belts, Earth's magnetic field and solar shortwave radiation

STATUS: Operational

PERFORMANCE: Orbit—Elliptical with apogees ranging from 933-200 miles and perigees from 200-126 miles; angles of inclination for I-III—49°— IV—65°; V-VI—not given

CONFIGURATION: Not released; however, believed to be larger than Vostok series

SPACE BOOSTER: Believed to be adapted from the smaller, more powerful military rocket tested in the Pacific during fall of 1961

PAYLOAD: Scientific instruments; also possibly carrying TV cameras for weather and reconnassaince purposes

REMARKS: Few details released; however, Khrushchev has referred to Cosmos as a "spaceship"; Cosmos IV after 72 hours in a nearly circular orbit was recovered April 29; contrary to past Soviet procedures, payload weights have not been announced; new series interpreted as Soviet challenge to American preeminence in area of instrumented studies of Earth's environment

Lunik I-III

TYPE: Space and lunar research vehicles

STATUS: Three flights—Jan. 2, Sept. 12 and Oct. 4, 1959

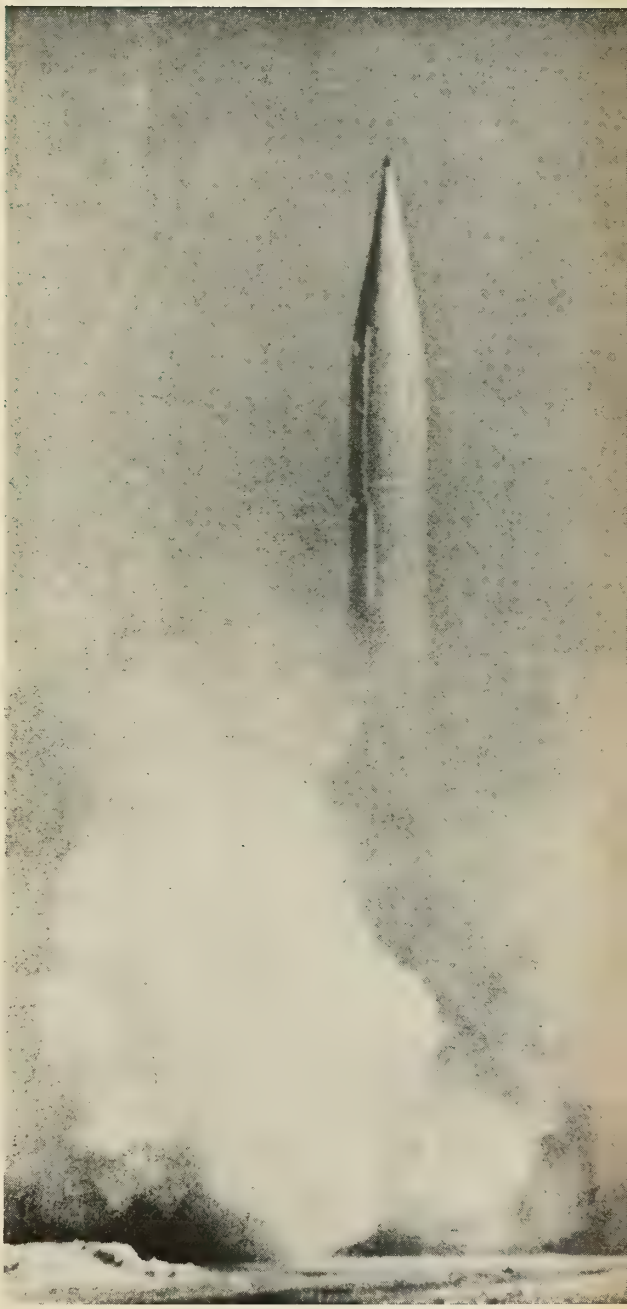
PERFORMANCE: Lunik I—solar orbit; apihelion—1.315 au; perihelion—0.9766 au; period—450 days; Lunik II—impacted moon Sept. 13, 1959; Lunik III—photographed back side of the moon; presumed down mid-April, 1960

FRAME: Lunik I&II — dimensions not released; Total weight — 3245 lbs.; Instruments — 800 lbs. (I), 858.4 lbs. (II); Lunik III—cylindrical; Length—87 in.; Diameter—47 in.; Total Weight—4037 lbs.; Instruments—959 lbs.

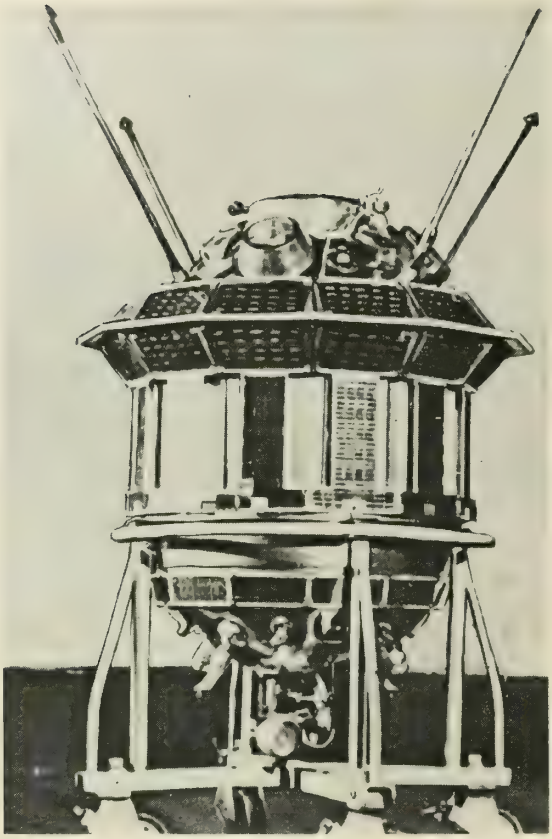
INSTRUMENTATION: Internal temperature and pressure measurement instruments; devices to study gas components of interplanetary matter and corpuscular radiation of the Sun, magnetic fields of the Earth and Moon, meteoric particles and heavy nuclei in primary cosmic radiation; Lunik III also carried two cameras, developing mechanism, automatic triggering devices for cameras, developing and transmission of pictures to Earth

SPACE BOOSTER: Believed to be a modified three stages T-3 ICBM

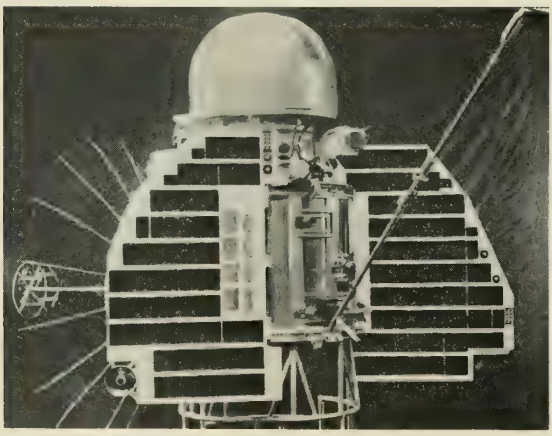
REMARKS: Lunik I — also called Mechta (Dream); Lunik II traveled 236,875 miles in 35 hours before impacting Moon; contained instruments and Soviet coat of arms; Lunik III produced photographs showing 70% of the Moon's far side; cameras triggered 40,000 miles from lunar surface and operated 40 minutes; closest approach to the Moon, 4372 miles on Oct. 6, 1959



VOSTOK LAUNCH



LUNIK III



VENUS PROBE

VOSTOK



Vostok I and II

TYPE: Manned spacecraft

STATUS: Two flights, April 12 and Aug. 6, 1961

PERFORMANCE: Vostok I: Apogee—187.66 mi.; perigee—108.76 mi.; Inclination—65.07°; Period—89.1 min.; Vostok II: Apogee—115.3; perigee—110.3; Inclination—64.1°; Period—88.6 min.

FRAME: Overall Length—35 ft. (est.); Diameter—8.8 ft. (est.); Reentry Body: Length—17 ft. (est.); Diameter—8.8 ft. (est.); Total spacecraft weight—10,418 lbs. (Vostok I), 10,430 lbs. (Vostok II); spacecraft believed to be cylindrical

INSTRUMENTATION: Included radio and TV equipment for monitoring condition of man, automatic life support equipment and telemetry; tape recorder; automatic and manual control equipment

SPACE BOOSTER: Not revealed

REMARKS: April 12 flight of Maj. Yuri A. Gagarin was the first orbital flight of a manned spacecraft; total time in orbit—1 hour and 48 minutes; Aug. 6 flight of Maj. Gherman S. Titov was the longest orbital flight by man (25 hours, 18 minutes); Titov experienced periods of nausea during his 17½-orbit flight.; spacecraft launched on May 14, Aug. 19 and Dec. 1, 1960, were designed to perfect the systems and techniques for Vostok series; only August 19 shot, however, was successfully recovered; Sputniks IX and X—launched March 9 and March 25, 1961—were also part of the spacecraft development series with animals in spacecraft being successfully recovered; weights and orbits of all spacecraft similar to those of Vostok series

Venus Probe (& Sputnik VIII)

TYPE: Interplanetary probe and Earth satellite

STATUS: One flight—Feb. 12, 1961

PERFORMANCE: Probe—Orbits Sun; apihelion—1.0190 au; perihelion—0.7183 au; period—300 days; Sputnik VIII—down Feb. 25, 1961

CONFIGURATION: Probe—Cylindrical; length—80 in.; Diameter—41 in. without antennas and solar paddles; Weight—1419 lbs.; Sputnik VIII—details not disclosed

INSTRUMENTATION: Devices to measure cosmic rays, magnetic fields, charged particles of interplanetary gas and corpuscular sunbeams, record micrometeor impacts and instruments for temperature control, telemetry, attitude control and stabilization

AUXILIARY POWER: Chemical batteries charged by solar batteries

REMARKS: Venus probe launched on interplanetary trajectory from Earth orbit; Soviets predicted that vehicle would come within 62,000 miles of Venus on May 19 or 20; however, early in March contact with the spacecraft was lost; any missions, other than launching probe toward Venus, that Sputnik VIII may have had were not announced. Sputnik VII—launched Feb. 4, 1961—is believed to have been an identical probe which failed to launch from orbit. Weights and orbital parameters support this theory

MISSILES

T-1 (Army)

TYPE: Surface-to-surface MRBM

STATUS: Operational

PERFORMANCE: Range, 400-600 miles

FRAME: Length, 62 ft.; Weight, 44,000 lbs.; single stage

REMARKS: Mobile. LOX/alcohol-fueled booster generates 77,000 lbs. thrust. Radio-guided. Nuclear capability

T-2 (Army)

TYPE: Surface-to-surface IRBM

STATUS: Operational

PERFORMANCE: Range, 1300-1500 miles; Speed, 5000 m.p.h.

FRAME: Length, about 66 ft.; Weight, 55 tons; two stages.

PROPULSION: 1st Stage, 1R-14A; Type, Liquid (LOX/kerosene); Thrust, 268,000 lbs.; 2nd stage, 1R-10; type, Liquid (LOX/alcohol); Thrust, 78,000 lbs.

REMARKS: The T-2 reportedly was the first Soviet rocket used to test an H-bomb warhead. Fired from Central Russia, the warhead was exploded at 120,000 ft. near Bennet Island in the Arctic

T-3 (Air Force)

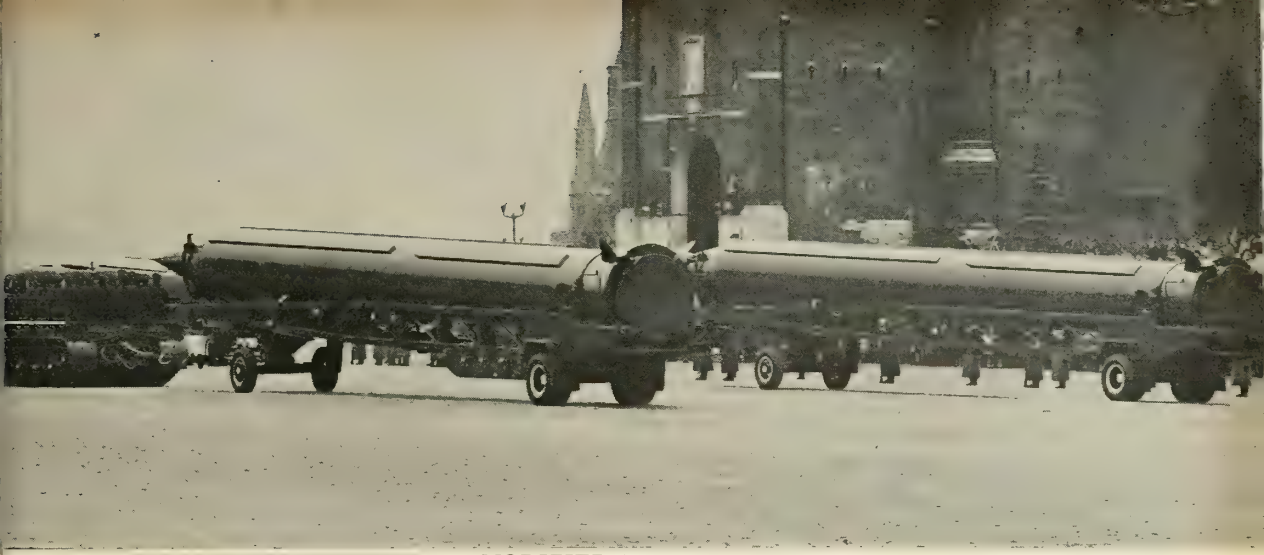
TYPE: Surface-to-surface ICBM

STATUS: Operational

PERFORMANCE: Range, 5000 mi.; Speed, 15,000 m.p.h.; Apogee, 280 miles

FRAME: Length, 88 ft.; Diameter, 11.5; Weight, 176,000 lbs.

PROPULSION: 1st Stage, 2R-14; Type, Liquid (LOX/kerosene);



MODIFIED T-1

Thrust, 440,000 lbs.; 2nd Stage, 1R-14A; Type, Liquid (LOX/kerosene); Thrust, 268,000 lbs.; 3rd Stage, 1R-10; Type, Liquid (LOX/alcohol); Thrust, 78,000 lbs.

REMARKS: Radio-inertial-guided. Production reportedly completed. Improved T-3 has 6500-mi. range. Nuclear warhead.

T-3A (Army)

TYPE: Surface-to-surface ICBM

STATUS: Operational

PERFORMANCE: Range (Model A), 6000 miles; Range (Model B), 7500 miles; Speed, 15,000 m.p.h.

FRAME: A—length, 92 ft.; diameter, 12 ft.; weight, 182,600 lbs. B—length, 102 ft.; diameter, 16 ft.; weight, about 400,000 lbs.

PROPULSION: A Model: 1st Stage, 2R-14A engines; Type, Liquid (LOX/kerosene); Thrust, 518,000 lbs.; 2nd Stage, 1R-14A; Type, Liquid (LOX/kerosene); Thrust, 268,000 lbs.; 3rd Stage, 1R-10; Type, Liquid (LOX/alcohol); Thrust, 78,000 lbs.; B Model: 1st Stage, 4R-14A; Thrust, 820,000 lbs.; 2nd Stage, same as A model; 3rd Stage, same as A model

REMARKS: Production of Model A ceased. The booster stage on the Model B is believed to be a prototype for one used in the T-4A antipodal missile. Nuclear warhead

T-4A (Air Force)

TYPE: Surface-to-surface ICBM

STATUS: Development

PERFORMANCE: Range, over 10,000 miles; Apogee, 186.3 miles; Speed, 13,660 m.p.h.

FRAME: Length, 121.02 ft.; Wing span, 65.6 ft.; Max. diameter, 10.2 ft.; Launch weight, 230,000 lbs.

PROPULSION: 1st Stage, 4 solid-propellant rocket motors; Thrust, 268,000 lbs.; 2nd Stage, 1R-14A; Type, Liquid (LOX-kerosene); Thrust, 268,000 lbs.; 3rd Stage, 1R-10; Type, Liquid (LOX/alcohol); Thrust, 78,000 lbs.

REMARKS: Catapulted from rail sled. Payload, 2350 to 3100 lbs. Radio-guided. Antipodal bomber is the Soviet counterpart of the U.S. X-20 boost-glide spacecraft stemming from the German Saenger-Bredt design conceived in World War II.

T-5B (Army)

TYPE: Surface-to-surface

STATUS: Operational

PERFORMANCE: Range, 15-25 miles

FRAME: Length, 31 ft.; Diameter, 3 ft.; Weight, 6000 lbs.

PROPULSION: Type, Solid; Thrust, 22,000 lbs.

REMARKS: Similar to the U.S. Honest John. Launched from tracked vehicle. Unguided. Carries HE and possibly a nuclear warheda. 5C model (similar to U.S. Little John) in production

T-6 (Army)

TYPE: Surface-to-air

STATUS: Operational

PERFORMANCE: Range, 20-25 miles; Speed 1500 mph; Ceiling, about 60,000 ft.

FRAME: Length, 22 ft.; Diameter, about 3 ft.; weight, about 4000 lbs.

WARHEAD: HE with proximity fuze

POWERPLANT: Booster, 4 solid-propellant motors; Thrust, 11,000 lbs.; Sustainer, 2 solid-propellant motors; Thrust, 2200 lbs.

REMARKS: Fired from multiple launcher. The T-6A is radar-guided and is believed to be operational

T-7A (Army)

TYPE: Surface-to-surface

STATUS: Operational

PERFORMANCE: Range, 50 to 90 miles; Speed, Mach 5; radio command guidance

FRAME: Length, about 30 ft.; diameter, 2.5 ft.; Weight, about 9,000 lbs.

POWERPLANT: Solid-propellant; Thrust, 11,450 lbs.

WARHEAD: HE

REMARKS: Comparable to U.S. Corporal. Has controllable rear fins

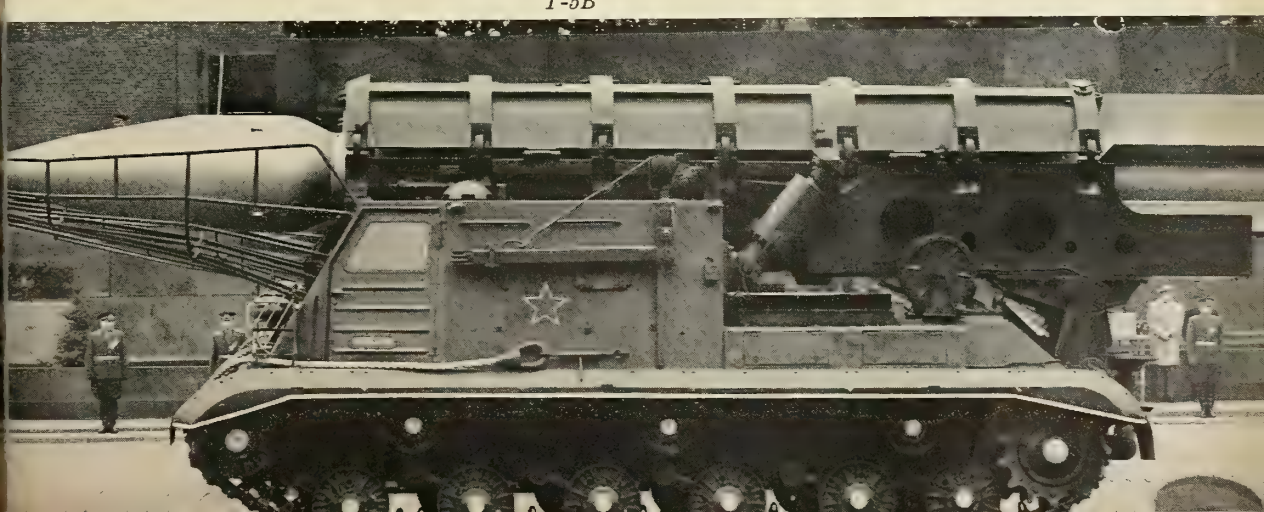
T-8 (Army-Air Force)

TYPE: Surface-to-air

STATUS: Operational

PERFORMANCE: Range, 15 to 25 miles; Speed, Mach 2.5; Ceiling, 79,280 ft.

T-5B



FRAME: Length, 13 ft.; Diameter, 1.05 ft.; Weight, 2,090 lbs.

PROPULSION: First stage, cluster of two solid fueled boosters; Thrust, 4000 lbs.; Second stage, liquid; Thrust, 4600 lbs.

WARHEAD: HE with proximity fuze

REMARKS: IR guidance. Deployed in East Germany in batteries of six launchers

Komet I (Navy-CH 17 Army)

TYPE: Surface-to-surface

STATUS: Operational

PERFORMANCE: Range, 100 miles; Speed, 3000 m.p.h.

FRAME: Length, 37 ft.; Diameter, 4 ft; Weight, 20,250 lbs.

PROPULSION: Type, Solid; Thrust, 53,000 lbs.

REMARKS: A program is under way to put the Komet I into service aboard submarines and surface ships. HE and nuclear warheads

Komet II (Navy-CH 18 Army)

TYPE: Surface-to-surface

STATUS: Operational

PERFORMANCE: Range 400 miles; Speed, Mach 7.5

FRAME: Length, 42 ft.; Diameter, 5.9 ft.; Weight, 41,350 lbs.

PROPULSION: Type, Solid; Thrust, about 100,000 lbs.

REMARKS: Operational with the Red Army and from a surface vessel in calm waters. R&D for submarines. Nuclear warhead

Komet D (Air Force)

TYPE: Air-to-surface standoff

STATUS: Development

PERFORMANCE: Range, 55 miles; Speed, Mach 1

FRAME: Length, 15 ft.; Diameter, about 4 ft.

PROPULSION: Type, Solid; Thrust, 5000 lbs.

REMARKS: An equivalent to the British Avro, the turbojet-propelled missile may have beam-riding guidance. Warhead can be either nuclear or HE

M-2 (Army-Navy)

TYPE: Surface-to-air

STATUS: Operational

PERFORMANCE: Range, 37 mi.; Speed, Mach 2; Ceiling 68,000 ft.

FRAME: Length, about 25 ft.; Diameter, 18 in.; Weight, 3970 lbs.

PROPULSION: Booster, Solid; Thrust, 9350 lbs.; Sustainer, Solid; Thrust, 4600 lbs.

REMARKS: Mobile. Infrared, radar, or both used as guidance. Advanced version reported to have 150,000-ft. ceiling



MISSILES ON SUBMARINE LAUNCHER

M-100A (Air Force)

TYPE: Air-to-air

STATUS: Operational

PERFORMANCE: Range, 3½ miles; Speed, Mach 2.5

FRAME: Length, 53 in.; Diameter, 3 in.; Weight, 85 lbs.

REMARKS: Solid-fueled, semi-active radio-radar command guidance

ME-Igor (Army)

TYPE: Antitank

STATUS: Operational

PERFORMANCE: Range, over 2 mi.; Speed, Mach .7

FRAME: Length, 48 in.; Diameter, 3 in.; Weight, 10.5 lbs.

REMARKS: Solid-fueled. Fired from bazooka tube. HE warhead

RS-132A (Air Force)

TYPE: Air-to-surface

STATUS: Operational

FRAME: Length, about 4 ft.; Diameter, 5.2 in.

PROPULSION: Solid-propellant motor

REMARKS: HE warhead; mounted on helicopter & aircraft for ASW and air-ground missions

Golem I (Navy)

TYPE: Surface-to-surface

STATUS: Operational

PERFORMANCE: Range, 400 miles; Speed, Mach 7; Altitude, 125 miles

FRAME: Length, 54 ft.; Diameter, 5.5 ft.; Weight, 16½ tons gross

PROPULSION: Type, Liquid; Thrust, 120,000 lbs.

REMARKS: Developed from German World War II plans for a sea-going V-2 (A-3). Radio-inertial guidance. Designed to be launched from a capsule towed by a submarine. Nuclear capability

Golem II (Navy)

TYPE: Underwater-to-surface

STATUS: Operational

PERFORMANCE: Range, 400 miles

FRAME: Length, nearly 60 ft.; Diameter, 7 ft.; Weight, 75,000 lbs.

PROPULSION: Booster, Liquid; Thrust, 240,000 lbs.; Sustainer, Liquid; Thrust, 72,000 lbs.

REMARKS: Advanced version of the Golem I with improvements adopted from the Army T-2. Probably radio-inertial guidance, liquid fueled. Nuclear capability

Golem III (Navy)

TYPE: Underwater-to-air, surface-to-air

STATUS: Operational on surface vessels. Development for land-based version

PERFORMANCE: Range, 10 miles; Ceiling, over 65,000 ft.

FRAME: Length, over 15 ft.; Diameter, 20 in.; Weight, about 4500 lbs.

REMARKS: Solid-fueled, infrared-guided. Designed to give both submarine and surface ships anti-aircraft protection

J-3 (Navy and Army)

TYPE: Surface-to-surface

STATUS: Operational with the Red Army and at least 7 Baltic fleet cruisers

PERFORMANCE: Range, 450-600 miles; Speed, supersonic

FRAME: Length, 36 ft.; Diameter, 4.5 ft.; Weight, over 20,000 lbs.

REMARKS: Booster is cluster of 4 solid-fuel rockets; ramjet sustainer. Guidance presumably is beam-riding or programed. Nuclear capability

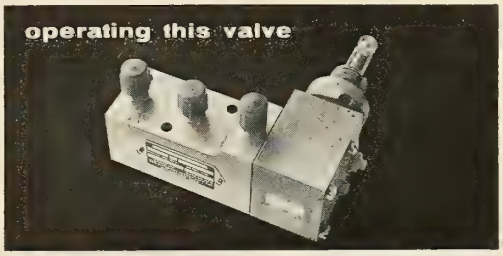


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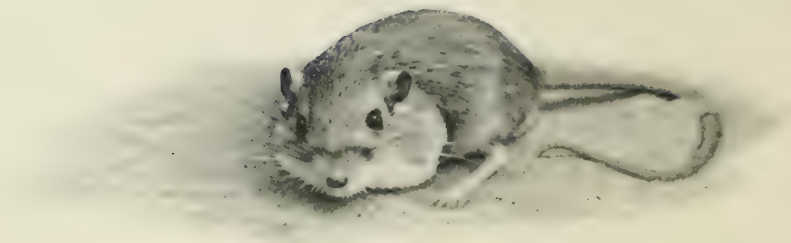


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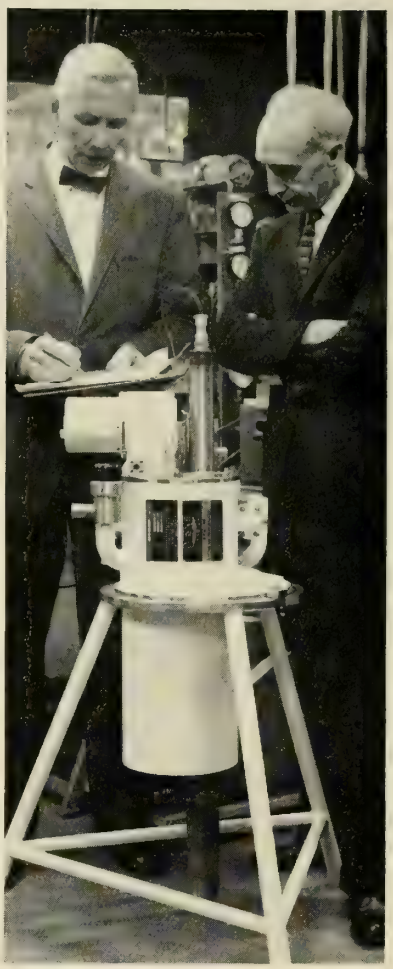
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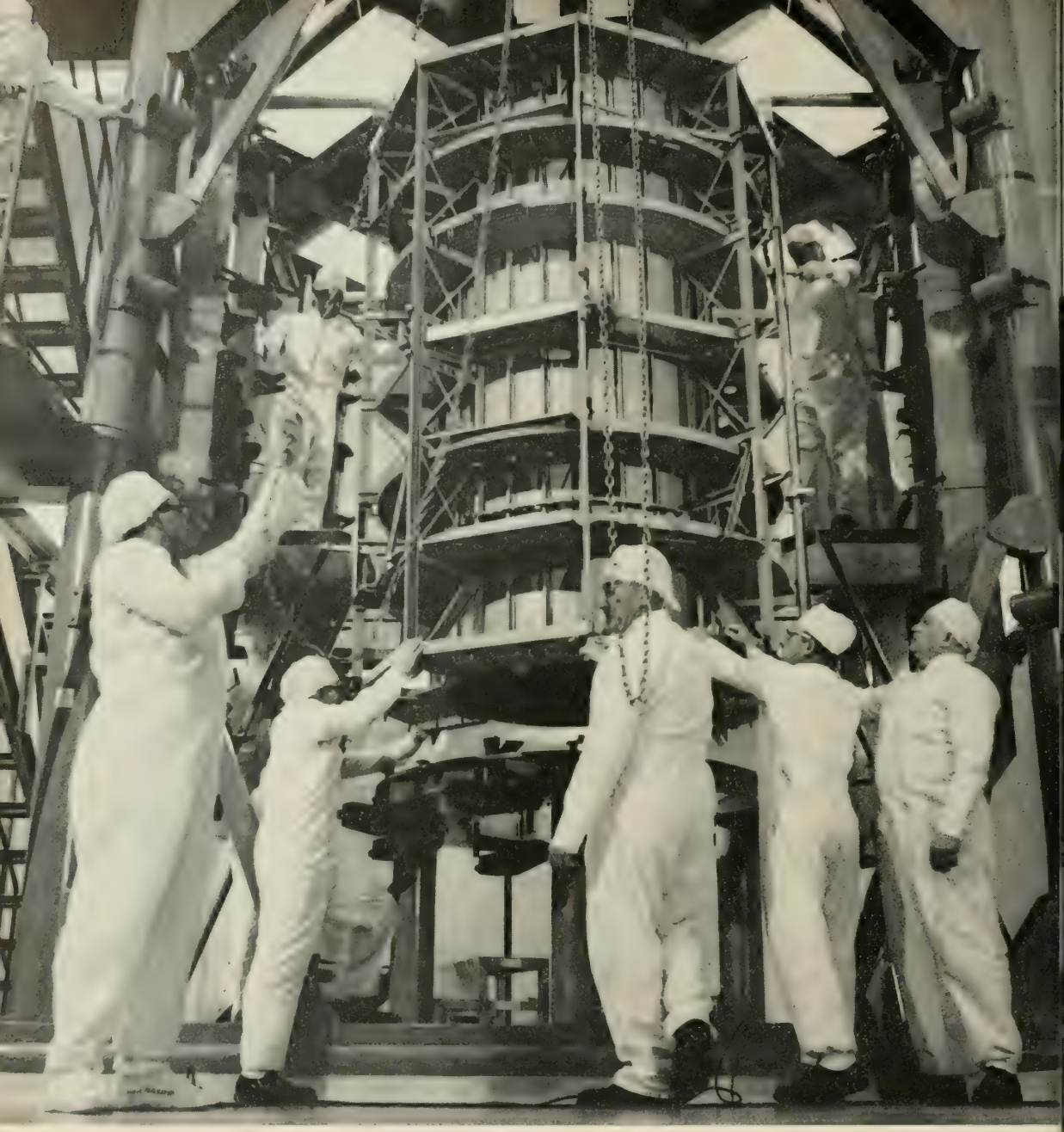
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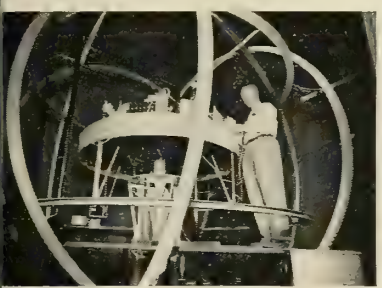
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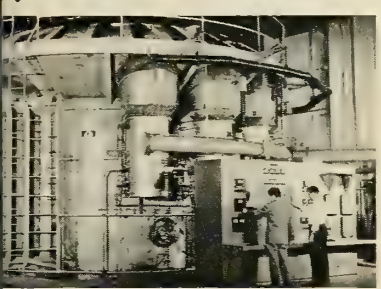
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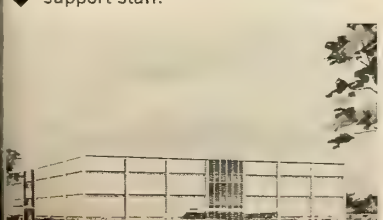
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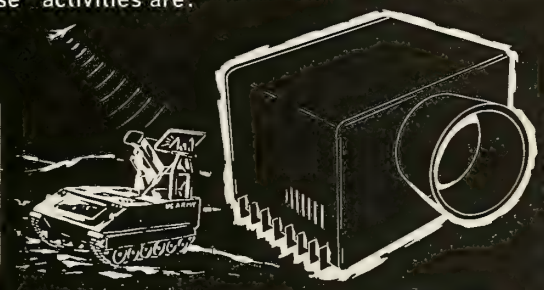
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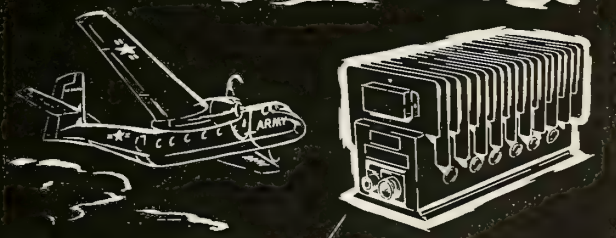
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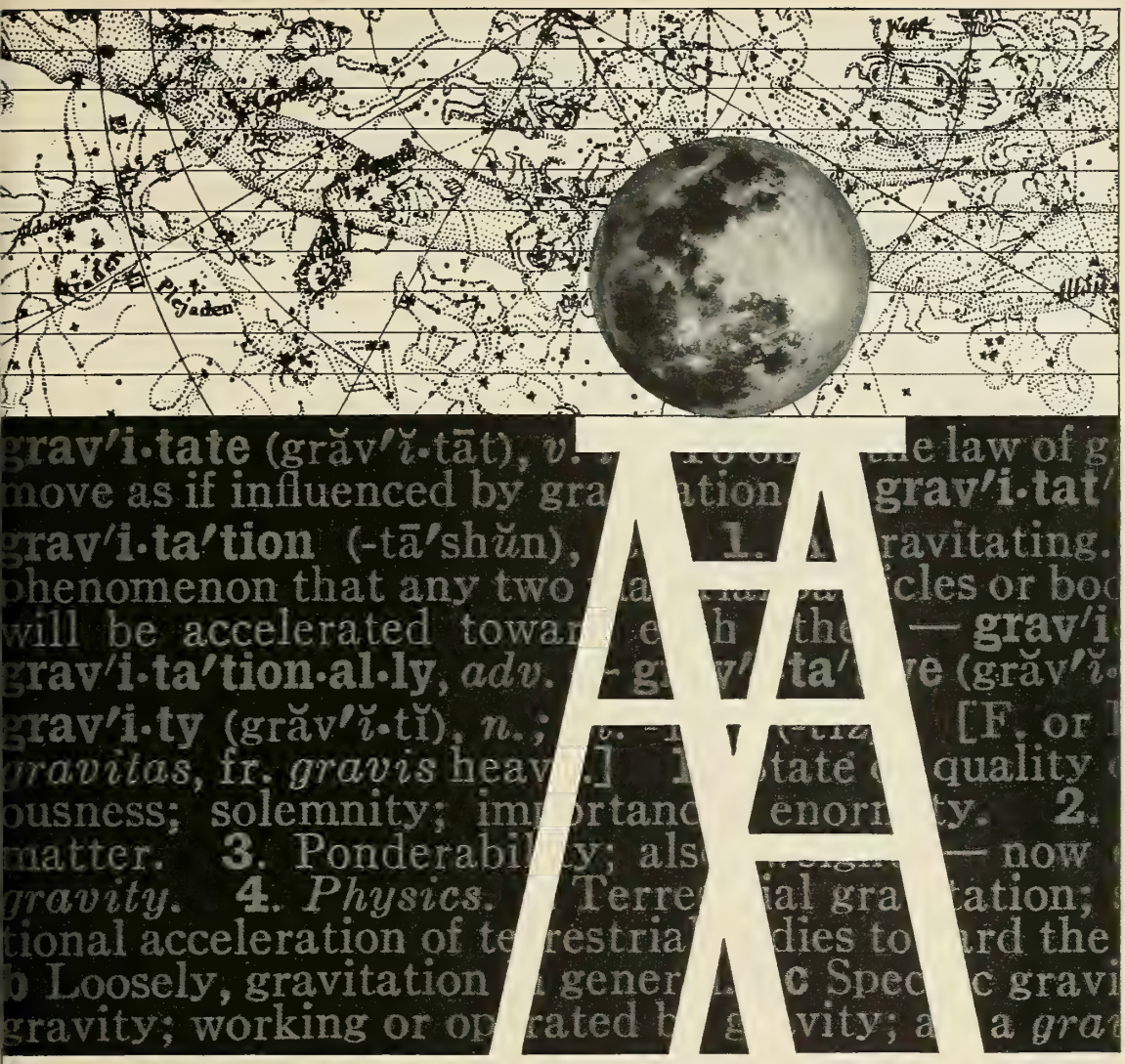
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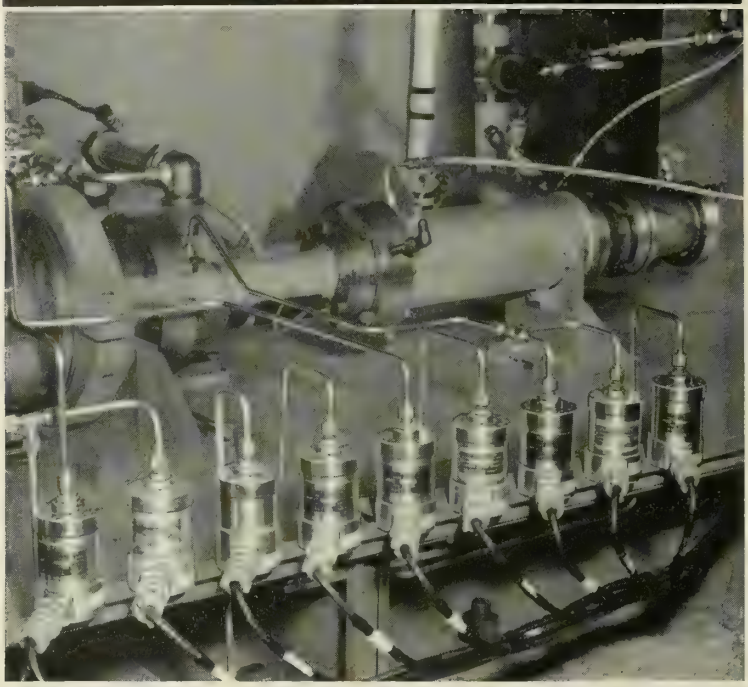


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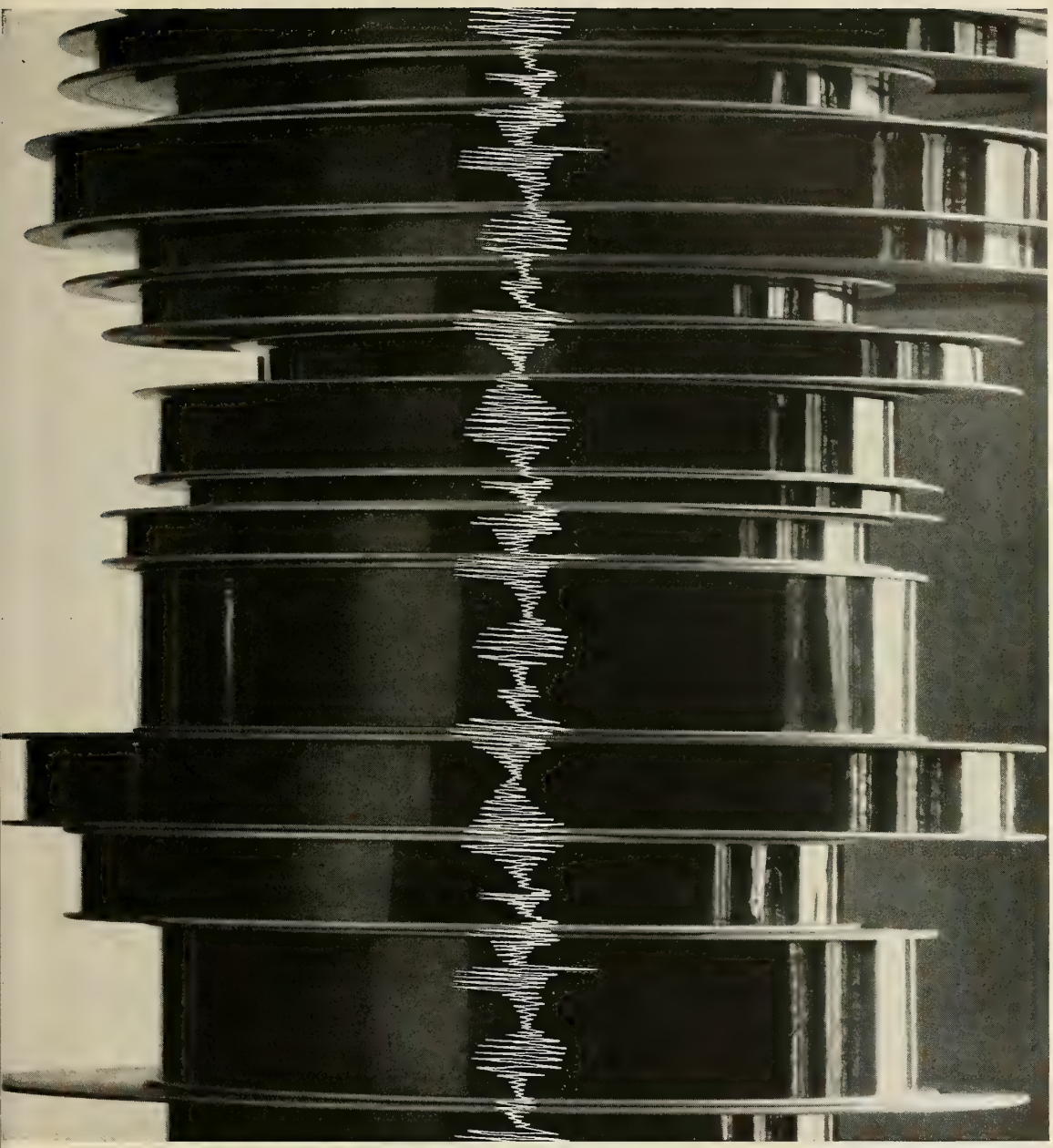
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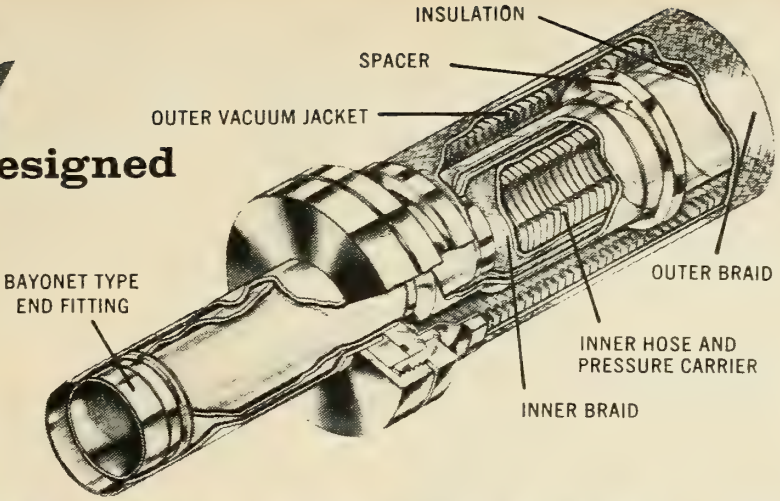
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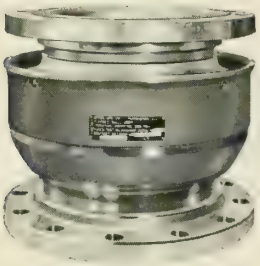
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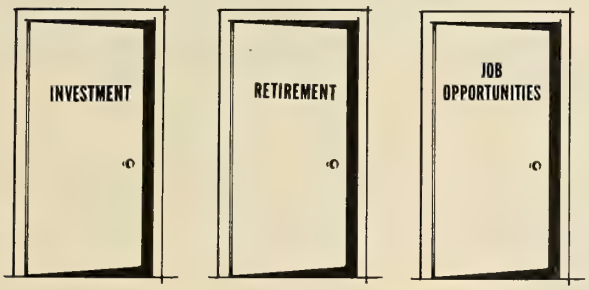
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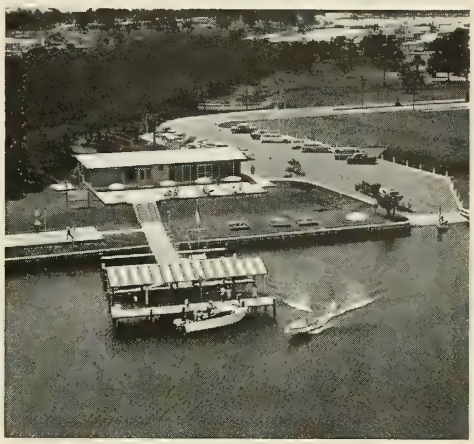
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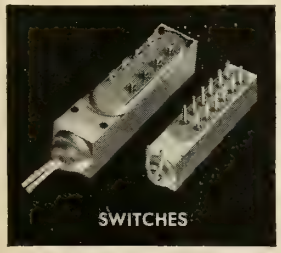
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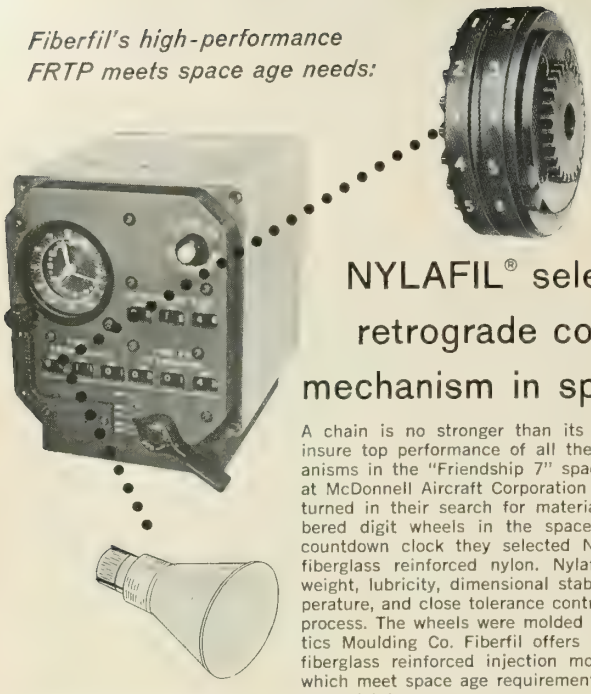
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OPTISYN® encoders benefit from useful "defect."



An example of moiré interference is shown in the photo. It is the basis for exceptional performance of DRC OPTISYN incremental optical shaft-angle digitizer.

Authoritative Chambers's *Technical Dictionary* defines *moiré effect* as "a 'watered-silk' pattern arising from interference between two line-screens: a defect for which occasional uses are found." We chuckle because Chambers's "defect" has proved to be our good fortune (we wish we could find more of them). And with OPTISYN now adopted as standard equipment on operational missiles, its use is becoming far from "occasional."

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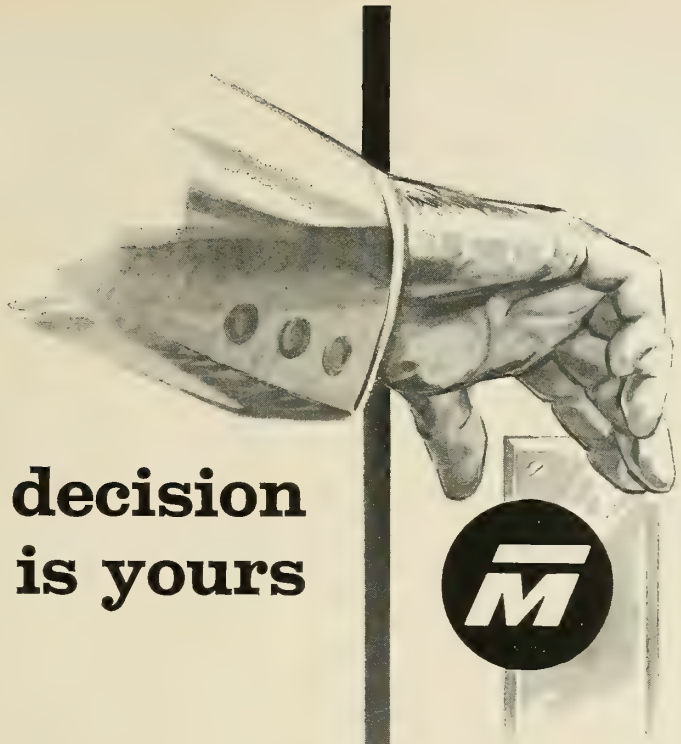
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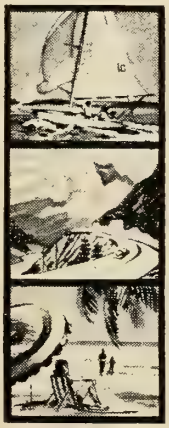


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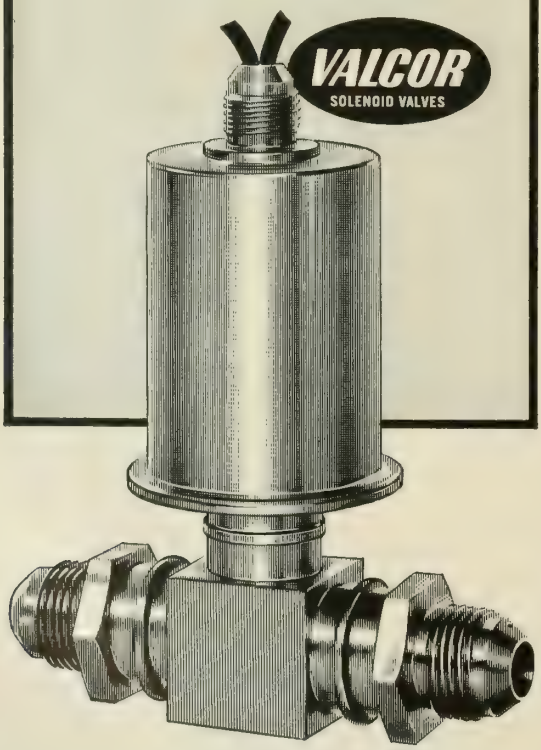
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A Chronology Of Fiscal 1962

JULY, 1961

July 21: Virgil I. (Gus) Grissom made 15-min., 118-mi.-high, 303-mi.-long flight—*MR-4*.
Discoverer XXVII was destroyed 60 seconds after launch from Vandenberg AFB.

July 24 week: GE announced cryogenic gyros, which would increase guidance accuracy by several orders of magnitude, were nearing testing. Aerojet-General Corp. awarded $6-million first-phase contract for development of nuclear rocket engine *NERVA*. President Kennedy signed NASA's Fiscal '62 appropriations bill providing a total of $1,784,000. $50-million Air Force R&D contract awarded to Hercules Powder for *Minuteman* third-stage propulsion.

July 25: Canaveral-launched *Titan* went 5000 miles guided for first time by "Achiever."

July 27: *Minuteman* successfully fired on 5000-mi. trip—third successful shot of year.

July 31: Joint AEC-AFSC test conducted to verify safety of nuclear devices in space. The 100-lb. package of telemetry and flare material rode Cape-launched *Atlas* 500 miles.

AUGUST, 1961

Aug. 2: *Polaris A-2* made successful 1400 mile trip from Cape pad.

Aug. 5: *Jupiter* IRBM fired 1500 miles by NATO troops using tactical GSE. United Technology Corp. fired a 40-ton segmented solid motor with flightweight case, producing approximately 250,000 lbs. thrust in 80 sec. Same week, Aerojet-General fired 55-ton, 500,000-lb.-thrust segmented solid motor.

Aug. 6: USSR's Maj. Gherman S. Titov orbited Earth for over 25 hours in *Vostok II*, Russia's second manned orbital vehicle.

Aug. 7 week: NASA dropped plans for middleweight *Saturn C-2* because of 50-ton minimum weight specification for *Apollo*.

Aug. 8: AF *Atlas F* went 5000 miles down AMR in model's first firing.

Aug. 14: Swedish scientists fired a U.S.-made *Arcas* over Lapland test range at Vidsel on Arctic Circle.
15-ft. *Aerobee* launched and ignited underwater in what Aerojet called "first successful achievement of its kind." *Explorer XII* launched and hailed as most informative U.S. satellite. Its highly elliptic orbit put it in contact with ground stations far longer than other orbiting spacecraft.

Aug. 15 week: NASA launched its *S-3* satellite designed to study relation between magnetic fields and space radiation. *Saturn* booster reached Canaveral after 2200 mile barge trip from Huntsville.

Aug. 21 week: NASA announced that there would be no more *Mercury* suborbital flights. *Polaris* destroyed 33 seconds after launch.

Aug. 23: *Ranger I* failed to go into planned orbit when *Agena B* failed to restart. It ended up in 105/312-mile Earth orbit.

Aug. 25: *Explorer XIII* micrometeoroid satellite launched on *Scout*. It re-entered Aug. 29.

Aug. 28 week: USSR announced it would resume nuclear testing.

Aug. 30: First attempt to launch untethered *Minuteman* from silo ended in flaming failure.
Discoverer XXIX orbited. Gen. Bernard Schriever announced that plans to orbit monkey in *Discoverer* series were scrapped.

SEPTEMBER, 1961

Sept. 1: Capsule recovered from *Discoverer XXIX*.

Sept. 6: *Titan* fired on successful full test, 6000-mi. flight with Mark IV re-entry vehicle.

Sept. 9: First full-scale *Nike-Zeus* test ended in explosion.

(Continued on page 138)



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Field engineering is a Sperry tradition. Our experience in supporting technical systems of every complexion began a half-century ago. Today Sperry has the field engineering responsibility for the giant FPS-35 Radar of USAF's Air Defense Command . . . for submarine navigation in Navy's *Polaris* missile program, and for the *Terrier* and *Talos* missile radar guidance systems also for Navy . . . for the Army's *Sergeant* missile system . . . for the Tracking and Discrimination Radar transmitters of the Nike Zeus missile complex . . . for the AMR program to convert two troopships into Mobile Atlantic Range Stations under sponsorship of the Missile Test Center of the Air Force Systems Command . . . and other similar programs.

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(Continued from page 136)

Sept. 11 week: Nortronics turned over to AMR world's biggest known ballistic camera, able to locate a missile at 1000 miles.

Sept. 12: Joe Walker flew *X-15* at Mach 5 to 100,000 ft. Air Force orbited *Discoverer XXX*.

Sept. 13: NASA and French scientists cooperated with experimental, four-stage sounding rocket launch from Wallops Island. NASA orbited a *Mercury-Atlas* carrying robot astronaut.

Sept. 14: *Discoverer XXX* caught in air-snatch.

Sept. 15: *Nike-Zeus* firing at White Sands successful.

Sept. 17: Air Force launched *Discoverer XXXI*.
French and NASA scientists launched *Nike-Asp* rocket from Wallops in one of series of spectacular tests releasing sodium and lithium vapor clouds at altitude.

Sept. 17 week: Defense Secretary McNamara announced amalgamation of three-division strategic Army Corps (STRAC) and Tactical Air Command (TAC) into unified command.

Sept. 19: Air Force failed to recover *Discoverer XXXI* capsule. *Bomarc B* intercepted and destroyed a supersonic *Regulus II* over Gulf.

Sept. 20: D. Brainerd Holmes, general manager of RCA's Major Defense Systems Division, named to post of director of manned spaceflight programs for NASA.

Sept. 23: *Titan I* passed first complete operation systems test.

Sept. 25: Electronics warfare equipment market predicted to more than double itself in next five years.

Sept. 26: Martin *Pershing* scored 18th success in 22 test launchings.

Sept. 29: Advanced thrust control system tested on 200-mile flight of *Polaris* fired from Cape. Device to be used on *A-3* and *A-4*.

OCTOBER, 1961

Oct. 2: *Atlas* plopped into South Atlantic 5000 miles from Cape. Army announced first successful firing of *Nike-Hercules* from new mobile battlefield transporter.

Oct. 2 week: Sperry's *Sergeant* missile completed contractor R&D test-firing phase and went into production.

Oct. 5: *Atlas* landed in Indian Ocean after 9000-mi. trip; data capsule recovered.

Oct. 6: *Titan I* with *Titan II* guidance system flew 5000 mi. down AMR.

Oct. 7: *Nike-Zeus* destroyed several seconds after launch.

Oct. 9: NASA announced that five firms had bid for *Apollo* prime.

Oct. 14: Air Force snatched *Discoverer XXXII* after one-day orbit. NASA and Canadian government launch *Argo D-4* rocket in ionospheric satellite program. Payload attained altitude of 560 mi., landing some 800 miles offshore.
X-15 flew to new record of 3920 mph with Joe Walker at controls.

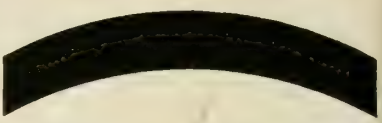
Oct. 16: Navy's largest nuclear FBM sub, the 410-ft. Ethan Allen, launched its

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All qualified applicants will receive consideration for employment without regard to race, creed, color or national origin.

NASA

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first *Polaris* while submerged 200 miles off Cape.

Oct. 18: NASA fired partially filled bottle of liquid hydrogen to altitude of 95 miles on *Aerobee-Hi* to test behavioral characteristics under zero-g.

Oct. 21: *Atlas-Agena B* which launched *MIDAS IV*, carried piggyback into orbit 75-lb. package containing 350 million copper dipoles in Project *West Ford* radio communications experiment (later lost). First launch of *Saturn* super-booster, set for this date, was postponed indefinitely. Meanwhile, seven firms bid on *S-1* stage.

Oct. 23: 1500-mile *A-2 Polaris* fired for first time from Ethan Allen. *Discoverer XXXIII* failed to orbit.

Oct. 23 week: NASA appointed Dr. Nicholas Golovin, George M. Low, Gen. Charles H. Roadman and Milton Rosen as *Apollo* management group bosses.

Oct. 27: *Saturn (SA-1)* performed as programed in launch from Cape, traveling 84.8 mi. high and 214.7 mi. downrange.

NOVEMBER, 1961

Nov. 1: *Scout* booster carrying 150-lb. checkout satellite to test *Mercury* tracking network destroyed in flight.

Nov. 2: Plans to attempt capsule recovery of *Discoverer XXXIV* abandoned after in-flight malfunction.

Nov. 7: Explosion in hydrogen system injuring five men forced cancellation of full-power run of Kiwi B-1A reactor.

Nov. 8. Ethan Allen sub completed sixth successful firing of *Polaris A-2* while submerged.

Nov. 9: Maj. Robert White piloted *X-15* rocket plane to record 4093 mph with windshield cracked.

Nov. 10: Air Force biomed experiment failed when *Atlas D* carrying squirrel monkey had to be blown up.

Nov. 13 week: Air Force signed a $15.4-million contract with Thiokol Chemical Corp. for first-stage *Minuteman* engines.

Bell Aerosystems Co. revealed a one-man propulsion system for astronauts.

Nov. 15: Navy launched *Transit IV-B*, with new *TRAAC* (Transit Research and Attitude Control) satellite of same weight riding piggyback. *Discoverer XXXV* orbited carrying special telemetry to determine cause of malfunctions preventing recovery of recent capsules. *BIOS I*, launched by NASA with biomedical experiments from PMR, lost.

Nov. 15: Test firings of *Asp-Apache* research rockets from Roi-Namur island off Kwajalein in Pacific begun by Army, as part of Highball series for *Zeus* test program.

Nov. 17: AF fired *Minuteman* from underground launching tube. Army had successful two-stage *Nike-Zeus* shot.

Nov. 18: NASA's *Ranger II* and backup *BIOS I* spacecraft both failed at the two missile ranges.

Nov. 20 week: *Polaris A-2* entered production. NASA said it would order at least 10 *Apollos*. Seventh missile tracking ship delivered to PMR. NASA awarded $200-million contract for 20 clustered 1.5-million-lb-thrust *Saturn S-1's* to Chrysler Corp.

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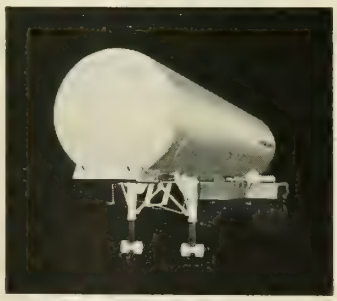


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Nov. 21: Army repeated successful two-stage *Nike-Zeus* shot, and had three successes in short-range tests of anti-missile missile at White Sands. First *Titan* to be launched by blue-suit crew fired down AMR (the warhead designed by GE for Pacific *Nike-Zeus* A-ICBM tests).

Nov. 22: Air Force launched either a *SAMOS* or *MIDAS* satellite from Pt. Arguello on *Atlas-Agena B.*

Nov. 28: North American Aviation won the coveted *Apollo* contract and began management talks wtih NASA.

Nov. 29: Chimp named Enos circled Earth twice in *Mercury* capsule and was recovered successfully, although technical problems caused a decision to bring down capsule after two rather than three orbits.

Nov. 29: SAC crew fired an *Atlas* from semi-hard launch pad at Vandenberg AFB in combat readiness test.

DECEMBER, 1961

Dec. 1: *Atlas* dumped a load of dummy nuclear fuel cores into the atmosphere during re-entry after 5000-mi. test.

Dec. 1-2: Two Marquardt advanced *Roksonde* meteorological sounding rockets launched at Cape, giving wind and temperatures above 180,000 ft. Flights followed 14 successful flights at White Sands.

Dec. 4: Air Force *Blue Scout Junior* rocket carried radiation-measuring instruments over South Pole after Arguello launch.

Dec. 11: General Dynamics Corp. emerged top DOD contractor for year with $1920.1 million. North American Aviation second, followed by Boeing, GE, Martin, United Aircraft, AT&T, Sperry Rand and RCA.

Dec. 11 week: *Explorer XII* satellite revealed that outer Van Allen belt composed of protons, not neutrons as was previously believed. Eastern Joint Computer Conference told that electronic data processing industry delivered $1 billion in equipment, and that current annual R&D expenditures in field are about $150 million.

Dec. 12: AF orbited *Discoverer XXXVI,* carrying ham radio satellite *Oscar* (10 lbs.). *Atlas F* released package of 28 dummy atomic fuel cells in study of how metals evaporate on re-entry on Cape shot.

Dec. 13: AF wound up *Titan I* R&D test program with 5000-mi. shot.

Dec. 14: *Nike-Zeus* passed extended atmospheric flight test after Pt. Mugu launch. *Trailblazer II* rocket launched from Wallops by Atlantic Research. *Nike-Zeus* intercepted *Nike-Hercules* over White Sands Missile Range. *Zeus* missiles also fired from Pt. Mugu and Kwajalein atoll.

Dec. 18: AF scored second success in row launching *Minuteman* from silo at Cape. Missile went 3600 mi.

Dec. 19: AF lost monkey which rode 5000 mi. in capsule aboard an *Atlas* fired from Cape.

Dec. 29: *Titan II* captive-fired for first time, in effort to reduce development time by year.

electronic engineers

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JANUARY, 1962

Jan. 1: Surveys showed that scientist/engineer shortage reaching panic point for government agencies and missile/space industries.

Jan. 5: *Minuteman* shot from underground silo—went 3200 mi.

Jan. 8 week: Kennedy Administration dropped decision made last May to develop solid-fueled *Nova* superbooster for initial manned lunar landing.

Jan. 13: *Aerobee* launched to altitude of 130 mi. from Wallops Island, to gather information for planning future astronomical satellites.
Discoverer failed.

Jan. 15 week: *X-15,* piloted by Neil Armstrong, rocketed to 3715 mph in test of new control system. NASA's *Echo* inflatable communications satellite torn to shreds shortly after injection from *Thor* booster. Longest *Pershing* flight—400 miles—met with complete success. *Atlas D* launched successfully from horizontally placed coffin launcher.

Jan. 20: SAC crew fired *Titan I* elevated from silo at Vandenberg.

Jan. 22: Kennedy Administration asked Congress to pour $16.2 billion into missile/space programs for FY '63 budget.

Jan. 22 week: Aerojet won $90-million contract to develop 1.2-million-lb.-thrust M-1 engine for *Nova* second stages.

Jan. 23: Second stage of *Polaris A-2* fired from Cape failed.

Jan. 24: *Composite I,* Navy's 5-satellite package failed when second stage of *Thor-Able Star* misfired. Martin *Mace B* fired from prototype hardened site in low-level flight test. 30th test firing of Army Martin *Pershing* successful.

Jan. 25: *Minuteman* roared 3200 mi. down AMR.

Jan. 26: First intercept of simulated enemy ICBM made by Army's *Nike-Zeus* antimissile missile.

Jan. 29: *Titan I* launch marked two milestones—50th and last developmental flight in *Titan I* series and first launch using all-inertial guidance system developed for advanced *Titan II* missile.

FEBRUARY, 1962

Feb. 1: *Nike-Zeus* shot successful from underground launcher. AF *Bomarc A* scored on *QF 104* drone aircraft over Eglin Gulf Test Range.

Feb. 7: *Nike-Zeus* scores again at White Sands.

Feb. 12: *Nike-Zeus* destroyed itself seconds after launch from Pt. Mugu.

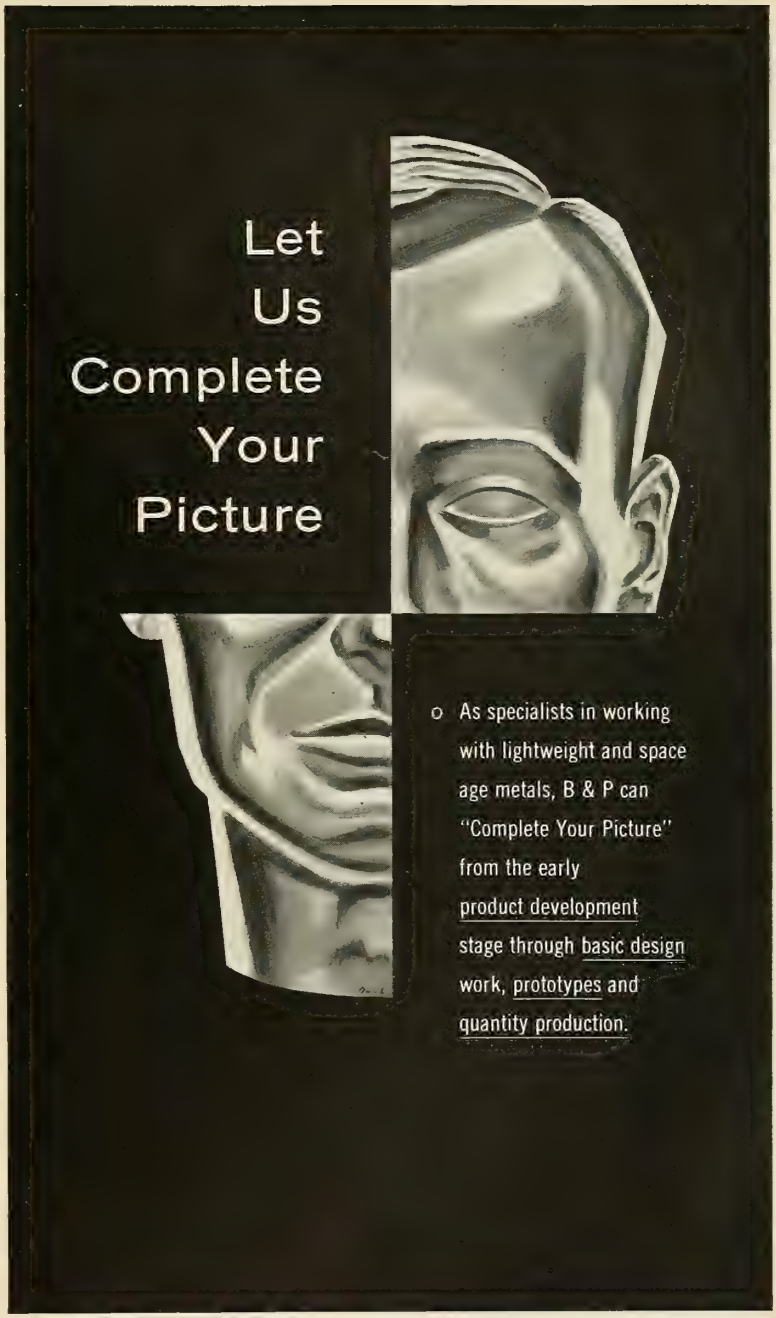
Feb. 13: *Atlas E* launched from Cape, noting end of training flights for the improved ICBM.

Feb. 16: Operational *Atlas* test made from coffin silo at Vandenberg AFB.

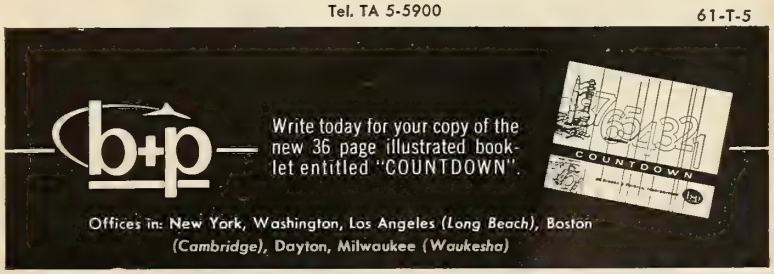
Feb. 20: *MA-6,* with Lt. Col. John H. Glenn aboard, was launched from Cape Canaveral at 9:47 a.m. and recovered after three Earth orbits.

Feb. 21: Air Force launched secret satellite from Vandenberg AFB.

Feb. 23: *Titan* launched from Vandenberg



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underground silo destroyed when second-stage ignition failed.

Feb. 27: *Discoverer XXXVIII* successfully launched, details secret.

Feb. 28: *Atlas E* fired from Vandenberg, traveled 4000 mi.

MARCH, 1962

March 1: Navy *Polaris A-2* launched from Cape carrying new lightweight guidance system developed by MIT for *A-3*.

March 2: AF air-snatched *Discoverer XXXVIII* after four days orbiting. *Mace B* successfully launched from Cape in final firings in *Mace* system operational test and evaluation program.

March 7: NASA's first *Orbiting Solar Observatory* successfully launched. AF launched classified satellite aboard *Atlas-Agena B* from Pt. Arguello.

March 5 week: Lockheed Propulsion Co. won $2-million contract from AF Systems Command for 120-in. solid rocket motor (segmented).

March 8: Three-stage *Nike-Zeus* met with failure.

Minuteman launched from underground silo and reached target 3000 mi. down AMR.

March 12 week: Eight firms submitted bids to NASA for Project *Fire* spacecraft. Large solid boosters eliminated from even a backup role in initial manned lunar-landing program.

March 13: *Nike-Zeus* scored back-to-back success with two *Zeus* missiles from White Sands against simulated ICBM targets.

March 14: First flight test of solid-propellant *Terrier Asp IV* made from Pt. Arguello by Navy.

March 16: Robert R. Gilruth awarded Dr. Robert H. Goddard Memorial Trophy for personal dedication in leading *Mercury* team. Biological package successfully launched and recovered in nose cone of meteorological rocket at PMR. Purpose: radiation studies.

March 19 week: France fired six missiles in successful series of test shots in Sahara. NASA presented $2.9-billion research, development and operations budget to Congress, including $863.6 million for manned spacecraft programs.

March 23: *Minuteman* scored its seventh consecutive success from an underground silo, traveling 4000 mi. from Cape.

March 28: *Nike-Zeus* intercepted a *Nike-Hercules* high above White Sands. Four-stage *Scout* launched by NASA from Wallops Island.

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March 30: *Polaris A-2* destroyed about 10 seconds after launch from Cape.

APRIL, 1962

April 6: USSR launched second satellite in three weeks, according to Tass. Name: *Cosmos II.*

April 9: AF launched secret satellite on *Atlas-Agena B. Atlas F* ICBM blew up on its pad at Cape, causing heavy damage and delaying missile test program about six weeks.

April 11: SAC made another successful *Atlas* launch.

April 11 week: Military directive spells out secret classification of launches.

April 12: *Nike-Zeus* fired from Pt. Mugu in test of all three stages. Failure of second stage of AF *Blue Scout* rocket to ignite resulted in loss of classified satellite package.

April 16 week: First of six squadrons of *Titan I's* goes operational at Lowry AFB. AEC awarded Pratt & Whitney Aircraft Div. of United Aircraft Corp. contract for design and development of *SNAP-50. Minuteman* rolled off assembly line at AF plant 77, marking opening of Boeing-operated production facility. Announcement that U.S. will build an aerospace research plane in 1965, with both NASA and Air Force participating. Disclosure that NASA will add about five to 10 astronauts to *Gemini* and *Apollo* program.

April 17: AF secret *Thor-Agena B* launch from Vandenberg.

April 18: Turkish NATO crew fired *Jupiter* 1500 mi. down AMR.

April 19: Test objectives in *Skybolt* program—in-flight launch and ignition, met in ALBM's initial firing from B-52 jet bomber.

Nike-Zeus destroyed in flight.

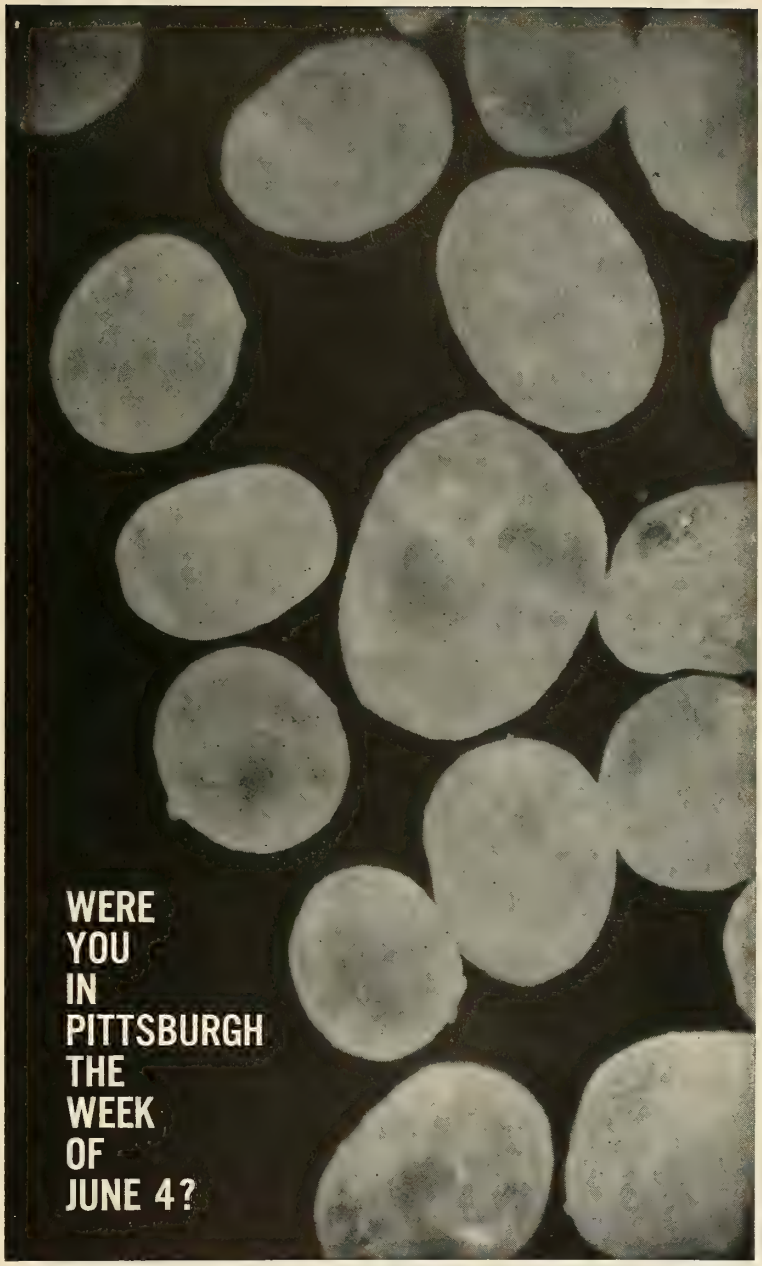
April 21: Fifth attempt in two weeks to launch *Centaur* from Cape failed when booster cutoff occurred just after ignition.

April 23: *Ranger IV,* after near-perfect launch and guidance phases, failed to transmit when timer malfunctioned.

April 24: *Minuteman* ended seven-shot success streak after malfunction in nighttime silo shot from Cape. Soviet Union launched *Cosmos III.*

April 25: Second successful test of the *Saturn* booster, with spectacular experiment in which 95 tons of water were released at 65-mi. altitude.

April 26: First international satellite, the *Ariel,* launched using U.S. *Thor-Delta* booster and British payload. Soviets orbit *Cosmos IV.*



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AF launched two more secret satellites.
Joint Japan-U.S. launch from Wallops.

April 27: *Nike-Zeus* had perfect three-stage flight.

April 30: NASA pilot Joe Walker shoved the *X-15* to new altitude record of 48 miles. *Nike-Zeus* scored once again at White Sands.

MAY, 1962

May 3: John H. Glenn, Gherman S. Titov address COSPAR meeting in Washington, D.C.

May 4: One hundredth missile—a *Titan I*—fired from Vandenberg AFB.

May 6: First nuclear-tipped *Polaris* launched from submarine Ethan Allen, detonated after successful flight in Christmas Island test area.

May 7 week: UTC won 120-in. million-lb.-thrust, segmented solid engine contract for the *Titan III* booster.

May 8: *Centaur* explodes spectacularly at Cape Canaveral.

May 9: *Nike-Zeus* met with partial success.

May 10: An unsuccessful attempt to launch *ANNA*, a geodetic satellite to increase accuracy of measurements of the Earth's surface.

May 11: AF completely successful with operational *Minuteman* launch.

May 12: Largest solid motor—120 in.—fired at Lockheed Propulsion Co., producing 400,000 lbs. thrust.

May 14 week: House-Space Committee slashes $116 million from NASA's $3.79 billion FY 1963 authorization bill. Second *Titan* squadron at Lowry AFB declared operational.

May 15: Secret AF launch from Vandenberg.

May 21 week: Air Force opens negotiations with industry for study contracts for manned satellite inspector system *(Saint II)*.

May 24: M. Scott Carpenter spent nearly an hour on the sea after overshooting his target for re-entry in an otherwise successful *Mercury-Atlas 7* shot which went for three orbits. At Beale AFB, Calif., a *Titan I* silo and missile exploded, hospitalizing seven and injuring 52 others during LOX defueling operation.

May 26: First full-thrust, full-duration firing of giant F-1 engine made at Edwards AFB. Thrust of over 1.5 million lbs. developed. Pt. Mugu *Nike-Zeus* firing success.

May 28: USSR launches *Cosmos V*.

May 28 week: NASA announced series of 80 *Nike* launchings at Cape to obtain

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high-altitude wind data to aid in designing space boosters.

May 31: Secret *Blue Scout* launch from Pt. Arguello.

JUNE, 1962

June 1: *Oscar II,* launched by AF for American Radio Relay League on *Thor-Agena B* in *Discoverer* series.

June 4: *Polaris* with new guidance system blown up. *Thor* booster carrying submegaton nuclear device for initial U.S. high-altitude test shot had to be destroyed.

June 7: *Titan II* launched from Cape on planned 5000-mi. test fell short but otherwise performed well.

June 8: *Minuteman* makes 12th success in 15 launches.

June 11 week: *Advent* program virtually cancelled by DOD when it announced that bids would soon be let for new, lighter, high-altitude communications satellite.

June 9: Aerojet-General fired segmented solid rocket attaining thrust level of 700,000 lbs.

June 12: Study contracts for manned *Saint* cancelled by DOD.

June 18 week: Air Force selects ALBM designed for supersonic RS-70 bomber based on design submitted by Hughes Aircraft. AF study program totalling $5 million put back in business for FY '63. Raytheon's MSD reports it is nearing completion of jam-proof IR communications system between moving airborne platforms up to 100 miles apart.

June 17-18: Two more secret satellites from Pt. Arguello and Vandenberg by AF.

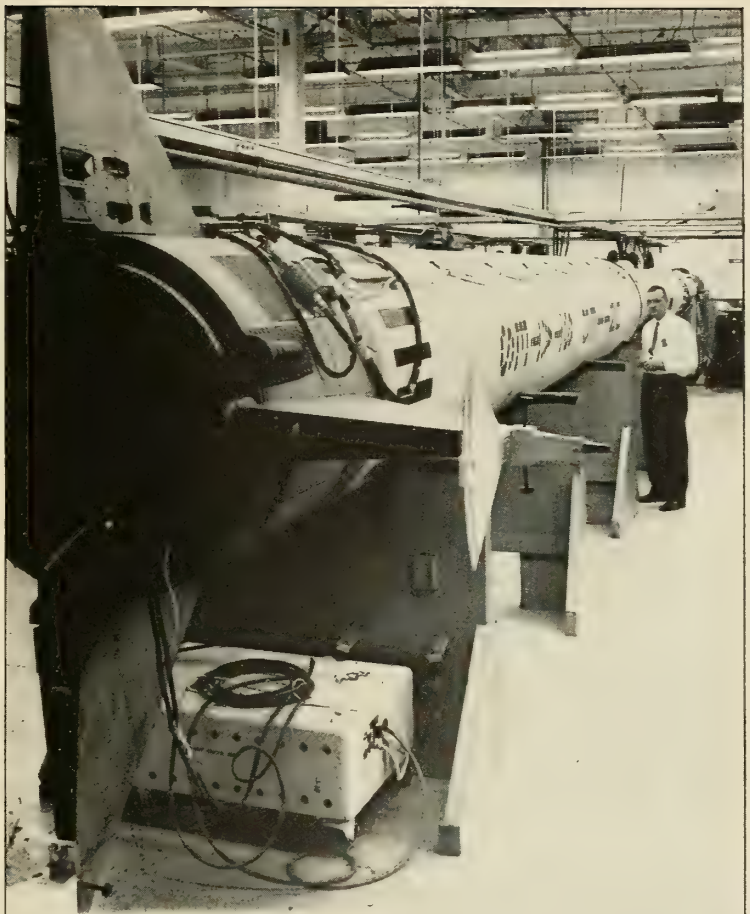
June 19: *Tiros V* launched successfully by NASA from Cape.

June 20: Nuclear-warhead-bearing *Thor* again destroyed after malfunction in Pacific tests.

June 21: Maj. Bob White sets altitude mark of 250,000 ft. with *X-15.*

June 25 week: *Dyna-Soar* renamed *X-20.* Contracts for *EMPIRE* (Early Manned Planetary-Interplanetary Roundtrip Experiment) awarded by NASA to six firms for six-month study. New high-energy liquid propelled experimental engine announced by NASA.

June 29: Land firing of *Polaris* carrying major components of advanced *A-3* conducted from Cape. *Skybolt* dropped from B-52 over Cape Canaveral failed to receive an ignition signal and plopped into ocean. AF team successfully fired *Minuteman* from Cape.



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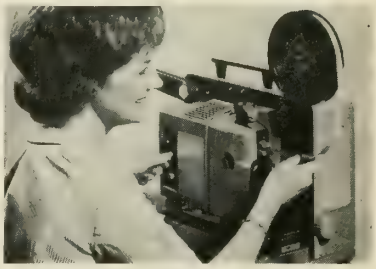
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products and processes



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The unit incorporates a unique "follow-the-numbers" system engraved on the controls.

The projector is virtually jam-proof, and a lost film loop is restored automatically. If damaged film loses tension at the sound drum, it can be restored quickly at a touch of a "systems restorer" control at the top of the threading channel.

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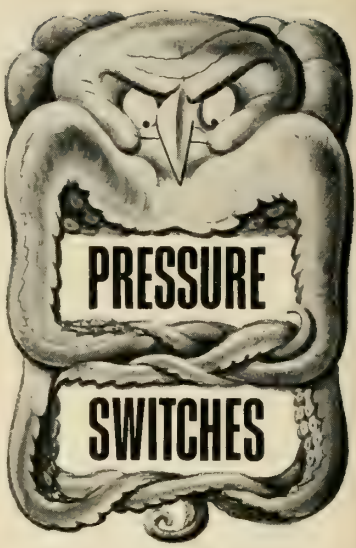
Fenwal Electronics is marketing a thermistor disc that has been soldered to a plate. This configuration gives rapid heat dissipation. The plate acts as a heat sink because the heat is distributed through a larger area. These assemblies are available with a large variety of thermistor resistances and are cycle-welded and lacquer-coated for environmental protection.

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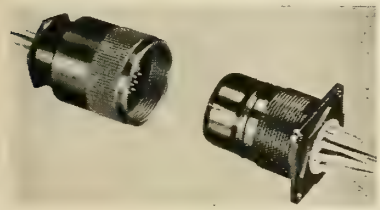
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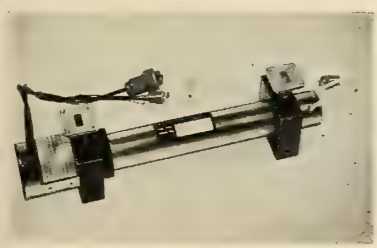
The unit operates from a 115 volt, 60 cps. line; however, it may be used with any a-c supply ranging from 25 to 125 volts and 25 to 400 cps. Typical applications include controlling power motors (up to ⅓ H.P.), solenoids, clutches, heater elements, etc., and the unit can handle surge currents up to 35 amps, operating on either resistive or inductive loads with 97% efficiency (115 volts a-c).

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Traveling Wave Tube

An octave-width K-band traveling wave tube, covering 10-20 Gc, is available from Microwave Electronics Corp. The tube is PPM focused and magnetically shielded, and meets all temperature and shock requirements of MIL-E-5400 Class II.

Model M2114E, is designed for use



with ECM receivers, for crystal protection, for reducing L.O. radiation, and for automatic gain control. It features low power consumption (3 watts maximum including heaters) and a wide dynamic range. Power output is 5 mw with gain at 25 db minimum. Voltage requirement is only 1500 volts maximum at 1 ma.

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ROVER FIELD TEST:

Several opportunities for B.S. to Ph.D. Physicists, B.S. to Ph.D. Electrical Engineers, B.S. to Ph.D. Nuclear Engineers, and B.S. or M.S. Mechanical Engineers.

At least 4 years' experience is required in one of the following areas:

Control Room Operations
Control System Design
Instrumentation and Data Analysis
Neutronics
Radiation Effects
Technical Review of Rocket or Reactor Test Facilities
Test Planning and Procedures

Employees will live in or near Las Vegas, but will be permanently assigned to work at the National Nuclear Rocket Development Center. Project Rover is operated by the Los Alamos Scientific Laboratory under the sponsorship of the AEC and NASA. Liberal compensation for extended work week in connection with field test work in Nevada.

* * * * * *

Also, some interesting and challenging positions are available at Los Alamos, New Mexico in the reactor design and development area.

ROVER DESIGN AND DEVELOPMENT:

Several opportunities for reactor specialists having a B.S., M.S., or Ph.D. degree in Mechanical Engineering, Nuclear Engineering, Civil Engineering, Aeronautical Engineering, Applied Mechanics, and Physics.

At least 3 years' experience is required in one of the following areas:

Reactor Test Analysis
Heat Transfer Analysis
Stress Analysis (preferably related to reactor design and structure)

The above work is to be performed for the Nuclear Propulsion Division at Los Alamos, New Mexico.

Employee benefits at both locations include:

★ 24 days annual vacation
★ 8 paid holidays
★ Ample sick leave
★ Progressive retirement plan
★ Liberal salaries

Laboratory representatives will be in attendance at the Nuclear Propulsion Conference in Monterey, California. For more information or for scheduling an interview while attending the Conference, call Mr. Robert Meier at Hotel Munras in Monterey (FRontier 5-2411), August 15, 16, or 17.

If inconvenient to call, send resume to

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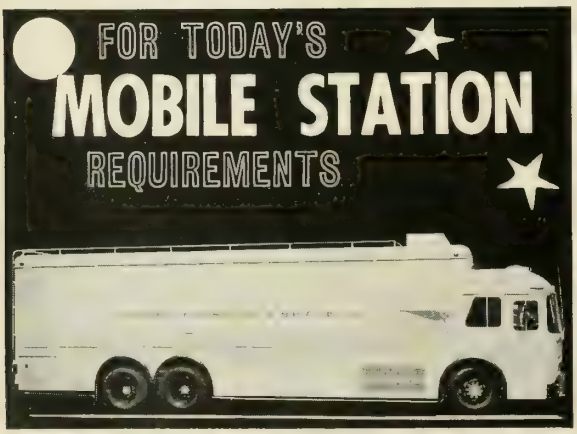
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Frequency Counters

Frequency counters for use in rockets and satellites to determine the frequency of incoming signals have been developed by Adcole Corp.

The first unit available in the space instrumentation series counts to 9999 and features an output to telemetry consisting of four decades, each having a staircase output from 0 to plus 5 volts in 10 steps. Clock pulses are derived from a 10-kc crystal oscillator which is divided to produce signals

Circle No. 231 on Subscriber Service Card

Acceleration Switch

A line of magnetic acceleration switches is available from Reeves Instrument Corp., a subsidiary of Dynamics Corp. of America. Designed to initiate a switching action when a predetermined acceleration level is reached, the switches find wide applications as warhead arming and/or disarming devices, for initiation of stage separation, control of parachute opening, missile and satellite re-entry controls, and for impact control and measurement.

Switches can be supplied on special order for sensing g levels as low as 0.1 g, or as high as 1000 g, and with tolerances to 1.0% of nominal.

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Thrust Microrocket

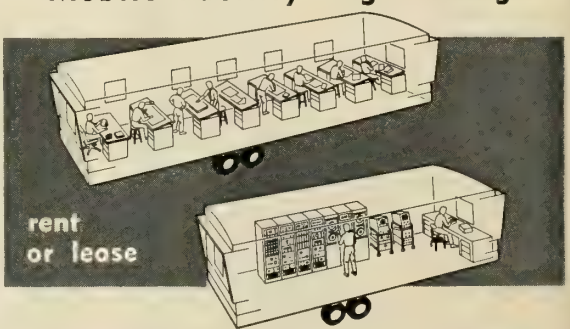
Rocket Research Corp. has available the Model R-1L liquid, bipropellant microrocket for attitude control, station keeping and orbit adjustments. One pound of thrust is developed at a delivered vacuum specific impulse of 305 sec. Propellants are N_2O_4 and 50-50 N_2H_4-UDMH. The radiation-cooled thrust chamber and valves weigh less than half a pound. Length, excluding valves, is 3⅜ in. A positive expulsion feed system, which does not require pressure regulators or weight penalties for pressurizing, is used.

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Frequency Divider/ Distribution System

RMS Engineering, Inc. is marketing a frequency divider and distribution system designed to perform the functions of frequency division, frequency multiplication and buffer amplification.

Model FDD achieves its versatility through the use of plug-in printed circuit modules to perform any of these functions or combinations thereof. The basic FDD chassis forms a card cage, into which may be plugged the various modules, up to 13 modules per chassis.

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Multi-Probe Temperature Indicator

A quick-reference precision temperature indicator with input receptacles for six temperature sensing probes is available from Imperial Electronics,

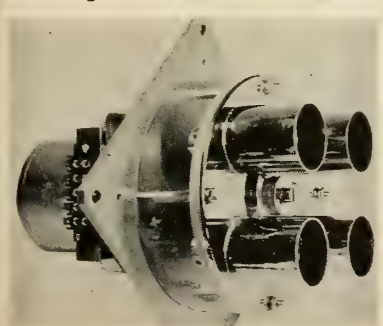


Inc. The model 1051-100 has three centrigrade temperature ranges 0°-25°, 25°-50°, 50°-75° distributed over a large 90° scale.

Circle No. 235 on Subscriber Service Card

Automatic Coaxial Switch

Andres Corp. is marketing Type 6730, 0-30 mc coaxial transfer switch. It is designed to automatically switch pairs of 1⅝ in., 50 ohm transmission lines in HF communication systems. Switching time is less than one second.



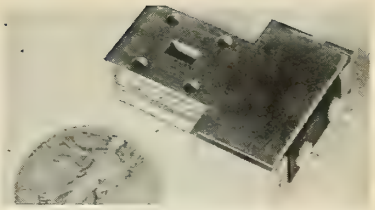
Size of switch permits mounting in compact switching matrices. Control circuitry for remote operation is included.

Circle No. 236 on Subscriber Service Card

Compact Waveguide Shutter

A compact, highly reliable waveguide shutter for use in Ka-band (34.5 to 35.2 Kmc) applications is available from Microwave Associates, Inc.

The MA-761 is a lightweight, remotely operated waveguide shutter designed to be easily incorporated in the receiver input waveguide to insure crystal protection from possible damage

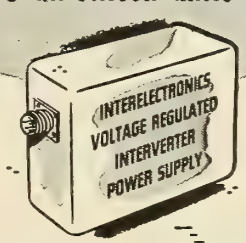


during equipment shutdown.

In the open position the insertion loss is 0.2 db maximum and VSMR (open position) is less than 1.10. Isolation in the closed position is 30 db. minimum. Switching time is 0.1 sec.

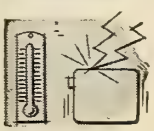
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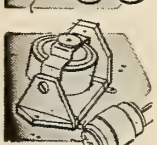












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Light weight (to 6 watts/oz.), compact (to 8 watts/cu. in.), low ripple (to 0.01 mv. p-p), excellent voltage regulation (to 0.1%), precise frequency control (to 0.2% with Interelectronics extreme environment magnetostrictive standards or to 0.0001% with fork or piezoelectric standards).

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AC single and polyphase units supply sine waveform output (to 2% harmonics), will deliver up to ten times rated line current into a short circuit or actuate MIL type magnetic circuit breakers or fuses, will start gyros and motors with starting current surges up to ten times normal operating line current.

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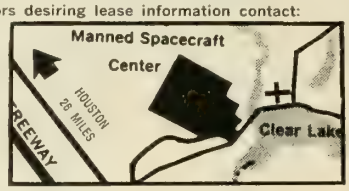
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—names in the news—

W. L. (Jim) Chadburn: Appointed sales manager of aeronautical products for Robertshaw-Fulton's Aeronautical and Instrument Div., Anaheim, Calif.

Charles W. Henderson: Elected administrative vice president of Ets-Hokin and Galvan, Inc., San Francisco.

Dr. Allen E. Puckett: Hughes Aircraft Co.'s vice president and head of the Aerospace Group, appointed vice chairman of the National Defense Science Board.

Mois Gerson: Appointed manager of the manufacturing department of the United AeroSpace Div. of United Electro-Dynamics, Inc., Pasadena, Calif.

Stanley H. Bulmer: Appointed manager of Wyle Laboratories' Test Facilities Dept., El Segundo, Calif.

Clarence I. Rice: Named president of John Oster Manufacturing Co.'s Avionic Div., Racine, Wis.

R. B. Bonney: Elected executive vice president of the Electronic Engineering Co. of California, Santa Ana. **W. R. McQuiston** elected vice president-sales.

O. C. Anderson: Appointed manager of the Data Processing Dept. of Brown Engineering Co., Huntsville, Ala.

William J. Normyle: Appointed director of public relations for the Martin Co.'s Space Systems Div., Baltimore.

Lou Davis: Appointed editorial and program director of the National Aeronautic Association, Washington, D. C.

James A. McKnight: Appointed manufacturing manager of the Systems Div. of Beckman Instruments, Inc., Fullerton, Calif.

James K. Palmer: Appointed liaison engineer in charge of contracts and engineering services for Emtech, Palo Alto, Calif.

Dr. Robert J. Gnaedinger: Named director of advanced development for American Micro Devices, Inc., Phoenix, Ariz.

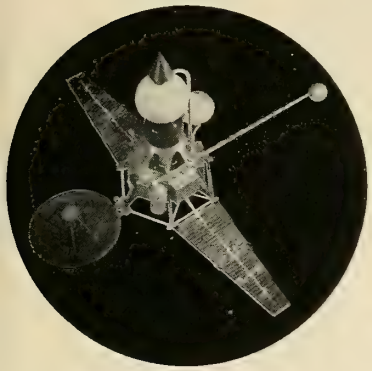
Dr. Franklin E. Lowance: Joined the Military Products Div. of Hoffman Electronics Corp., Los Angeles, as chief scientist.

John L. Sigrist: Appointed vice president and director of programs for the Douglas Missile and Space Systems Div., Santa Monica, Calif.

Dr. Robert J. Sunderland: Appointed senior research scientist of MHD Research, Inc., Newport Beach, Calif.

Dr. John C. Carlson: Appointed director of management planning and control for the Glendale Branch of General Precision's Librascope Div. in California.

space systems



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Dr. Herbert Ellern: Named staff scientist for Unidynamics, a division of the Universal Match Corp., St. Louis.

Dr. Clyde Melvin Adams, Jr.: Appointed to the technical staff of the Mitron Research and Development Corp., Waltham, Mass.

John F. Carey: Appointed director of government sales for the Electric Autolite Co., Toledo, Ohio.

Jacob Tellerman: Named chief engineer and director of development for the Systems Div., of Temco Instrument Inc., Plainview, N. J.

Dr. Dietrich Jenny: Joined Hughes Aircraft Co., Newport Beach, Calif., as manager of the semiconductor division.

Charles B. Slack: Joined the engineering staff of Waugh Engineering Div., of the Foxboro Co., Van Nuys, Calif., as manager, aerospace products.

Richard J. Petschauer: Named staff engineer of Fabri-Tek, Inc., Minneapolis.

Jackson T. Wills: Named regional manager of customer relations of Aerojet-General Corp., Azusa, Calif.

Dr. Albert R. Hibbs: Appointed head of the Arms Control and Disarmament Group at the Jet Propulsion Laboratory of the California Institute of Technology, Pasadena.

William E. Maschal: Appointed assistant general manager-management systems of the Douglas Aircraft Div., Long Beach, Calif.

Roger Waterman: Named assistant western region armed forces liaison representative for the Douglas Missile and Space Systems Div., Santa Monica, Calif.

Robert J. Maroni: Appointed vice president-defense marketing of General Precision, Inc., Tarrytown, N. Y.

Hal O. Schmokel: Appointed project leader for advanced development at the Emerson Research Laboratories Div., of Emertron, Inc., Silver Spring, Md.

Dr. Jerry S. Kidd: Appointed principal staff scientist of Aircraft Armaments, Inc.'s systems engineering department, Cockeysville, Md.

Harold Marchant: Appointed manager of digital devices, Scientific Data Systems, Inc., Santa Monica, Calif.

John C. Barron: Named director of systems requirements of General Precision, Inc., Tarrytown, N. Y.

Arthur F. Dickerson: Named manager of advanced engineering for the Advanced Product Planning Operation (APPO) of General Electric's Electronic Components Div., Schenectady, N. Y.

Roy P. Jackson: Appointed vice president and assistant general manager of the Northrop Space Laboratories, Beverly Hills, Calif.

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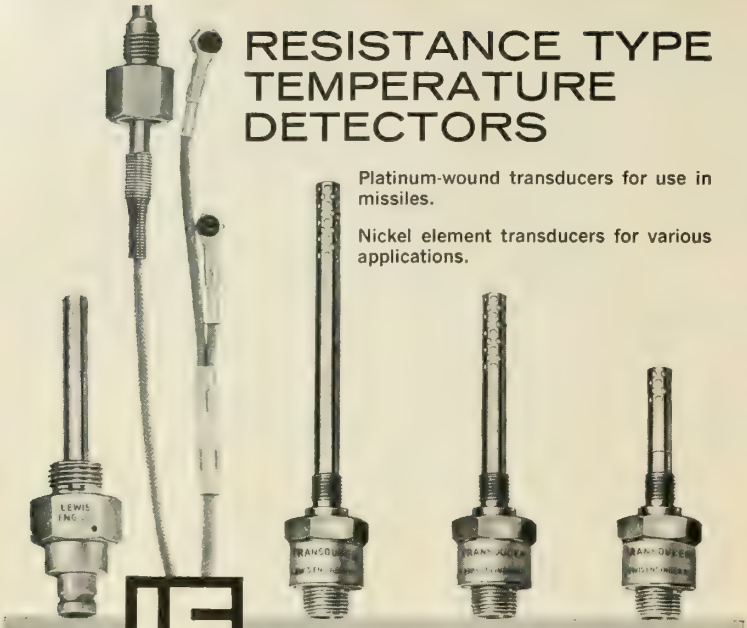
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—when and where—

AUGUST

Engineering Foundations Engineering Research Conference on Composite Materials, Tilton School, Tilton, N. H., Aug 1-3.

International Conference and Exhibit on Aerospace Support, Washington, D. C., Aug. 4-9.

Fifth Annual Institute on Missile Technology, University of Connecticut, Storrs, Aug. 5-17.

Society of Photographic Instrumentation Engineers, Seventh Annual Symposium, Statler Hilton Hotel, New York City, Aug. 6-10.

Low-Level Wind Conference, sponsored by American Meteorological Society and U. S. Army Signal Missile Support Agency, Texas Western College, El Paso, Tex., Aug. 7-9.

57th Meeting, National Aerospace Standards Committee, Aerospace Industries Association, Benjamin Franklin Hotel, Seattle, Aug. 7-9.

1962 Standards Laboratory Conference, National Bureau of Standards' Boulder Laboratories, Boulder, Colo., Aug. 8-10.

Institute of the Aerospace Sciences, Man-Machine Competition, Olympic Hotel, Seattle, Aug. 10-11.

Pacific Energy Conversion Conference, American Institute of Electrical Engineers, Fairmont Hotel, San Francisco, Aug. 13-16.

International Science Writers Seminar, sponsored by American Institute of Physics with the cooperation of the American Institute of Biological Sciences and American Chemical Society, Seattle, Aug. 13-16.

Seventh Symposium on Ballistic Missile and Space Technology, U. S. Air Force Academy, Colorado Springs, Colo., Aug., 13-16.

Conference on Lunar Exploration, sponsored by National Science Foundation, Langley Research Center of NASA, and Virginia Polytechnic Institute, VPI, Blacksburg, Va., Aug. 13-17.

Cryogenic Engineering Conference, University of California at Los Angeles, Aug. 14-16.

Nuclear Propulsion Conference, sponsored by ARC, AMS and IAS, U. S. Naval Post Graduate School, Monterey, Calif., Aug. 15-17. (All sessions are classified.)

Third International Electronic Circuit Packaging Symposium, University of Colorado, Boulder, Colo., Aug. 15-17.

American Society for Quality Control, Joint Western Regional Aircraft and Missiles Conference, Benjamin Franklin Hotel, Seattle, Aug. 16-18.

contracts

AIR FORCE

$34,520,000—**Boeing Co.,** Seattle, for production of *Minuteman* missiles and related equipment.

$25,300,000—**North American Aviation, Inc.,** Los Angeles, for development and production of guidance and control systems for *Minuteman* missiles (3 contracts).

$13,808,643—**Sperry Gyroscope Co.,** Great Neck, N. Y., for instrumentation of ships for the Atlantic Missile Range.

$12,000,000—**General Electric Co.,** New York City, for work on space vehicles (supplemental contract).

$11,290,000—**Aerojet-General Corp.,** Sacramento, Calif., for production of Stage II *Minuteman*.

$10,563,000—**Aerojet-General Corp.,** Sacramento, for research and development, fabrication, test and delivery of *Titan II* propulsion systems.

$8,000,000—**Radio Corp. of America,** New York City, for operation, maintenance and logistic support of the White Alice communications system in Alaska.

$7,480,000—**Boeing Co.,** Seattle, for work on the *X-20 (Dyna-Soar)* program.

$6,595,153—**Continental Consolidated Corp.,** Jacksonville, Fla., for construction of inner complex antenna facilities at *Titan II* missile sites at Davis-Monthan AFB, McConnell AFB, and Little Rock AFB (3 contracts).

$5,880,000—**Aerospace Corp.,** El Segundo, Calif., for systems engineering and technical direction of missiles and space programs.

$5,137,000—**Aerojet-General Corp.,** Azusa, Calif., for fabrication, test and delivery of *Titan II* propulsion systems (supplemental contract).

$4,900,000—**Lockheed Aircraft Corp.,** Burbank, Calif., for a space subsystem (supplemental contract).

$4,230,008—**Boeing Co.,** Seattle, for *Minuteman* ground support equipment and hardware (supplemental contract).

$3,625,000—**General Motors Corp.,** Detroit, for guidance systems for the *Titan* missile. Work to be done at Milwaukee.

$3,100,000—**Lockheed Aircraft Corp.,** Burbank, Calif., for research and development of space systems (supplemental contract).

$2,680,000—**Aerojet-General Corp.,** Sacramento, Calif., for research and development, fabrication, test and delivery of *Titan II* propulsion systems (supplemental contract).

$2,225,000—**Paul Hardeman, Inc.,** Stanton, Calif., for installation and check-out of transfer systems for missile propellants at various Air Force bases.

$1,907,000—**Douglas Aircraft Co.,** Santa Monica, Calif., for *MB-1 Genie* rocket fuses (supplemental contract).

$1,870,690—**American Bosch Arma Corp.,** Garden City, N. Y., for depot-level maintenance for *Atlas* missiles.

$1,290,144—**Aerojet-General Corp.,** Azusa, Calif., for research and development of Stage II *Minuteman* (supplemental contract).

$1,250,000—**International Telephone & Telegraph Corp.,** for work on a classified communications project at Paramus, N. J.

$450,000—**Boeing Co.,** Seattle, for study of the use of solid-fuel rockets to boost manned space vehicles into orbit.

$159,000—**General Dynamics/Convair,** San Diego, Calif., for development of a directional airborne antenna receiving system that will track missile nose cones re-entering the atmosphere.

Kollsman Instrument Corp., Elmhurst, N. Y., for study of feasibility of manual space position-fixing aboard orbital and space vehicles (undisclosed amount).

ARMY

$1,748,500—**Radio Corp. of America, Defense Electronics Products Div.,** Moorestown, N. J., for work on Project DAMP (Down-Range Anti-Missile Measurement Program).

$850,000—**Ryan Aeronautical Co.,** San Diego, Calif., for specialized target operational services with *Firebee* jet drones at the White Sands Missile Range.

NAVY

$4,020,068—**General Precision, Inc., Librascope Div.,** Glendale, Calif., for *Asroc* fire control system components.

$3,000,000—**Sperry Gyroscope Co.,** Great Neck, N. Y., for updating *Talos* missile radars.

$914,000—**Motorola Military Electronics Div.,** Scottsdale, Ariz., for fabrication, test and delivery of a quantity of airborne radar transponders.

$250,000—**Huyck Systems Co.,** Huntington Station, L. I., N. Y., for design, development, manufacture and installation of a fire-control and missile-launch simulator.

NASA

$204,000—**General Dynamics/Fort Worth,** Tex., for research on combined effects of nuclear radiation and cryogenic temperatures on materials for nuclear powered space vehicles.

INDUSTRY

$24,000,000—**Melpar, Inc.,** Falls Church, Va., from **Autonetics division of North American Aviation,** for high-reliability circuit boards for the *Minuteman* missile.

$142,800—**Systron-Donner Corp.,** Concord, Calif., from **Thiokol Chemical Corp.,** for automatic data systems for the *Minuteman* environmental test program.

$20,000—**Instrument Corp. of Florida,** Melbourne, Fla., from **Martin Marietta Corp.,** for optical studies during vehicle re-entry simulating nuclear-powered satellites to be used in Project *SNAP*.

Bendix Corp., North Hollywood, Calif., from **Sperry Rand Corp.,** for underwater beacons which will provide positioning information to ships involved in tracking missiles and space vehicles (undisclosed amount).



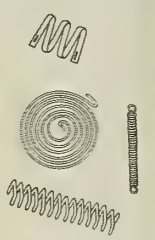
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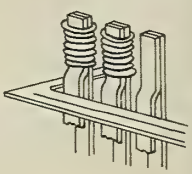
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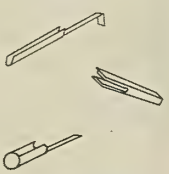
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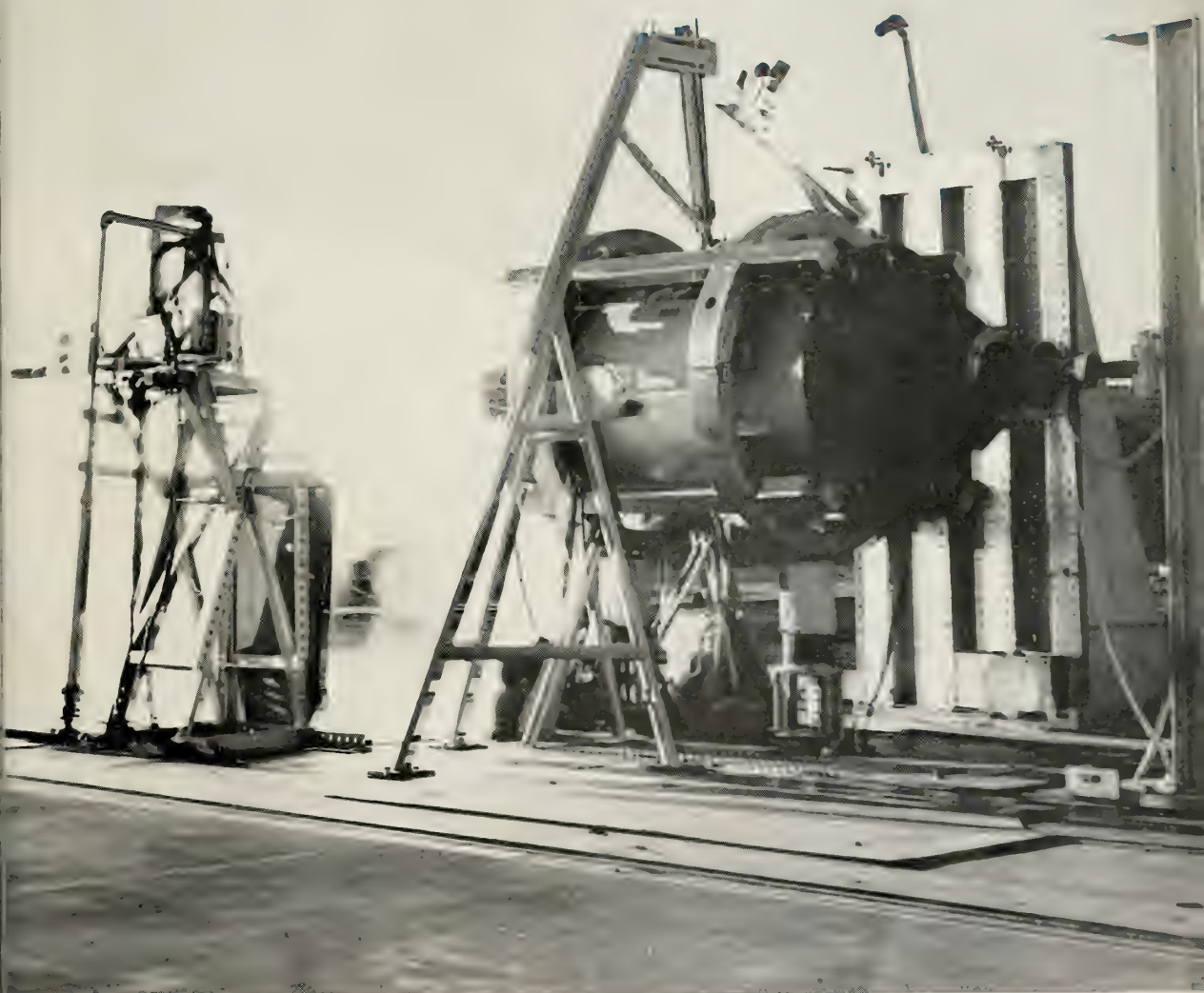
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missiles and rockets

Volume 11, Number 6 August 6, 1962

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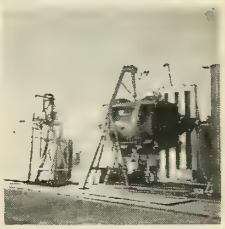
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THE COVER

Third-stage Minuteman engine is test-fired by Hercules Powder Co. Hercules and Thiokol Chemical Corp., which makes first-stage Minuteman engines, have built huge new production plants in Utah. *See p. 16.*



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memo from the publisher

THIS WEEK MARKS the beginning of a new weekly editorial service for our readers. You will note that on pages 40 and 41 we have expanded the Contracts section to include Requests for Bids on major contract negotiation by both the Department of Defense and NASA.

We discovered through our Research Department that many of you, particularly in the subcontracting area, do not have an available source for this information. This is just one of a continuing list of added services planned for MISSILES AND ROCKETS in the next few months.

•

NEXT IN LINE for Special Report treatment is the subject of Space Electronics. Our staff currently is developing a complete marketing and technical report on this subject, to be published in the issue of September 17. This report will encompass market trends, estimates and forecasts through 1970. Technical features on guidance, control and navigation, telemetry, detection and tracking, data handling, range instrumentation and checkout systems will be included.

•

MISSILES AND ROCKETS readers will be pleased to know that William Beller, one of the top hands in aerospace reporting circles, has been promoted to the post of senior editor. His extreme interest and competence in reporting on aerospace subjects will become accelerated in his new post. Bill—whose background included experience as a foreign correspondent, a stint as managing editor of *Aero Digest,* and co-authorship of the book "Satellites"—has a new book, entitled "Skyhooks," coming out next month.

He is not only an expert journalist but boasts a bachelor's degree in mechanical engineering and a masters in aeronautical engineering. Aside from his duties on M&R, he is active as a consultant on space matters, having served on the House Space Committee which established NASA.

•

EXPANSION continues in the editorial department with the recent addition of Lawrence J. Curran as copy editor. Larry came to M&R from *Tooling and Production* magazine and brings with him a seasoned background in publication journalism.

His experience also includes editorial staff assignments with *Metlfax,* a monthly metalworking magazine; *The Explorer,* a publication dealing with the natural sciences; military duty as a weekly newspaper editor, and work as a reporter for *The Worcester Telegram and Evening Gazette,* Worcester, Mass.

Larry is a graduate of Washington & Jefferson College, Washington, Pa., and has done post-graduate work at Western Reserve University, Cleveland.

Further additions to the staff are contemplated and will be announced shortly.

•

EDITORIAL is not the only area we are expanding. I am pleased to report that M&R circulation is at an all-time high, well in excess of 38,000 paid subscribers. In the past one year, circulation has grown by 5,341 new subscribers. This record reflects by far the fastest growth rate of any paid subscription magazine serving the aerospace field. Upwards of 50% of this gain has resulted from the subscriber card found in each issue. This means that you are passing your copy of M&R along to an associate. We appreciate it.

James W. Clear

PUBLISHER

letters

No Short Shutdown

To the Editor:

YOUR UNEQUIVOCAL STATEMENT IN M/R JULY 2 COUNTDOWN THAT WE ARE BEING FORCED TO SHUT DOWN IS CAUSING US CONSIDERABLE HARM OVERSEAS. WE DO NOT, REPEAT DO NOT, INTEND TO CLOSE NOR TO CEASE SEACAT PRODUCTION AND YOUR STATEMENT SHOUD BE RETRACTED IMMEDIATELY.

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Engineers and Education

To the Editor:

Letters to you regarding the shortage of engineers, their misuse, their equivalent, etc., certainly have brought out a widespread range of viewpoints. I was particularly amused at Mr. Timmons' letter in the July 2 issue in which he complains that a degree is necessary to be an engineer in industry. I have no complaint (or knowledge) about his technical competence, but his frustration seems to be one of status and title. This is apparently a widespread feeling, and some companies have taken positive steps to alleviate this condition. I have been in places in which you can guess what the Sanitation Engineer does.

As for Mr. Timmons' legislation to abolish academic achievement from the application, why stop there? Education, or "dirty discrimination," as Mr. Timmons calls it, has undoubtedly proved to be a valuable measure of an applicant to the personnel department. Education might even be used as an argument against the testing he advocates, since this is pretty well taken care of in any good college.

Omer E. Lamborn
Kansas City, Mo.

Spur-Snap 50

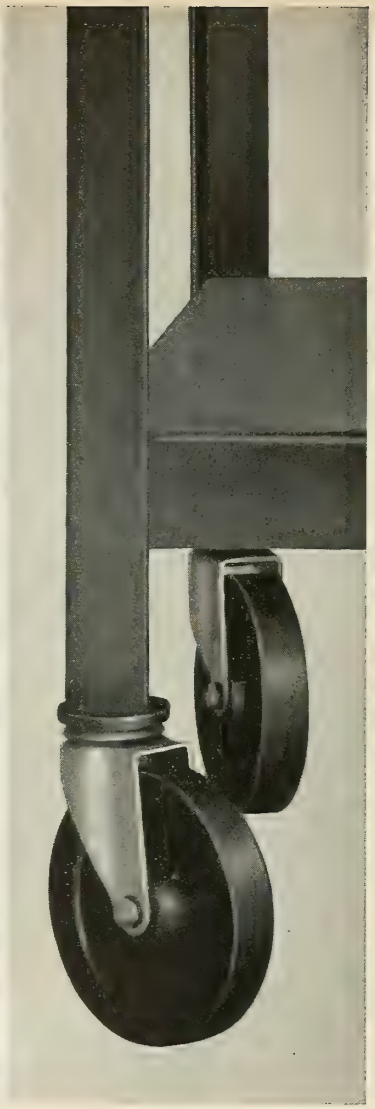
To the Editor:

I thought William Beller's article in M/R, July 23 about the big *SPUR-SNAP 50* squabble was very interesting. There seem to be an absolutely incredible number of influences boiling underneath the surfaces of this situation!

Somebody has really got to get into this picture with a real RICKOVER approach and get this thing off of dead center!

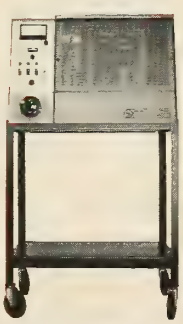
I certainly hope you will keep digging into the situation and ferreting out the facts which the main participants apparently prefer to keep hidden.

Burnet Outten, Jr.
Monterey, Calif.

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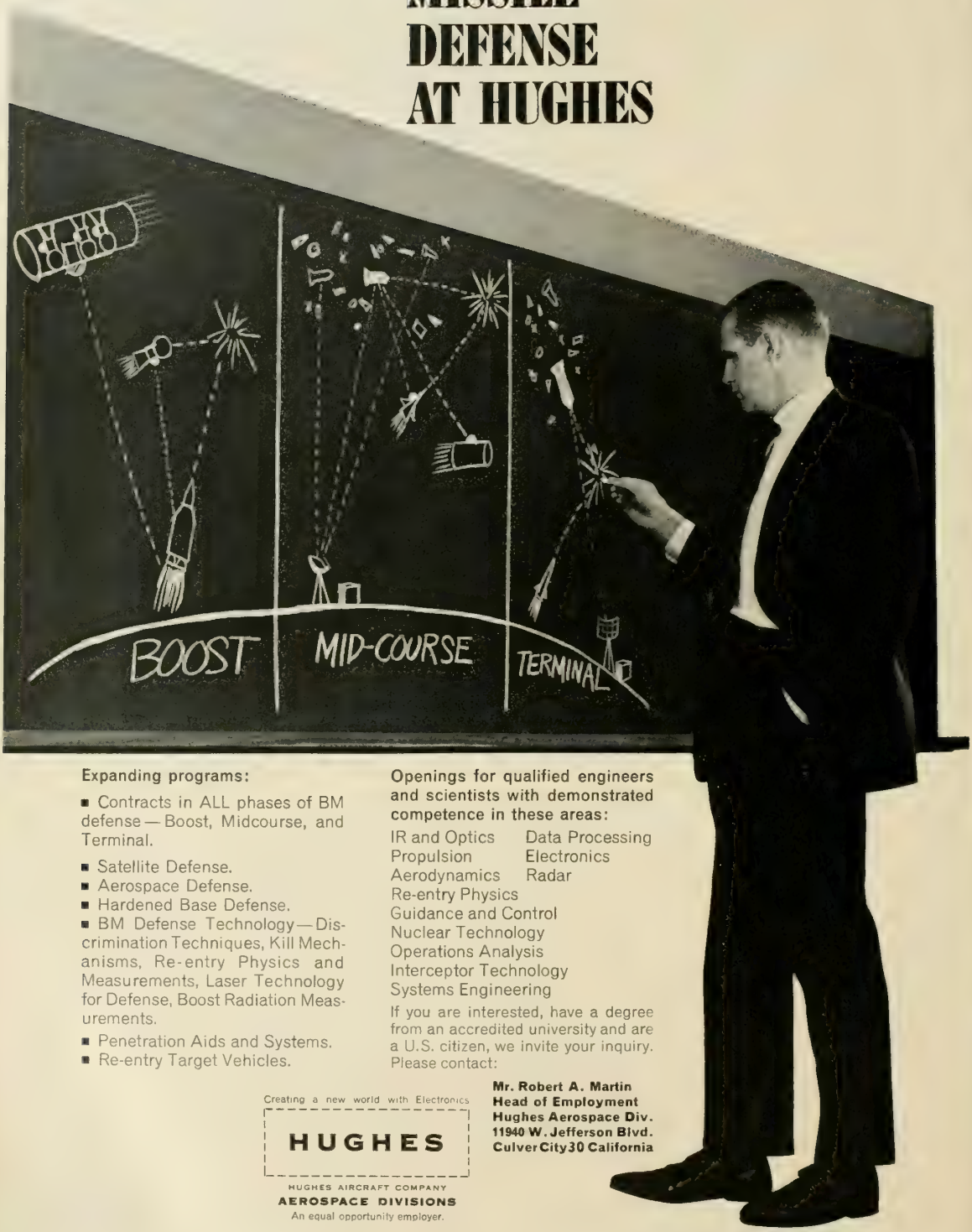
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The Countdown

WASHINGTON

House Committee to Probe Solids

House Space Committee will hold hearings this week on the big solid booster programs. Question: What has happened to the 156-in. and 260-in. programs? Among the witnesses scheduled: AF Gen. Bernard A. Schriever and NASA's Thomas Dixon.

White Sands Launch for Apollo

NASA's announcement of White Sands Proving Ground, N.M., as the launch site for boilerplate *Apollo* flight tests with the *Little Joe II* booster is imminent. It is probable that only one launch pad will be built.

Centaur Report is Delayed

NASA and industry officials met last week at Marshall Space Flight Center to consider whether management changes are needed in the ill-starred *Centaur* launch vehicle program. Also discussed: whether a DX priority would speed up development. The House Space committee has given NASA ten additional days to reply to its critical report of *Centaur* development. NASA's reply now is due Aug. 13.

Missile B Announcement is Due

Army announcement of contractors for *Missile B* program definition contracts is expected shortly. Two-month awards are expected with the development contract probably coming in October.

New Versions of Minuteman on the Way

Air Force is developing two improved versions of the solid-fueled *Minuteman* ICBM. The program still is under wraps, but AF apparently has adopted the same plan Navy used for extending range of the *Polaris*. The Mod II scheduled for Wing II at Malmstrom AFB will have a fiberglass second stage while the Mod III will have fiberglass throughout and perhaps an improved guidance system. Weight savings will be used to outfit the missile with a completely new, radical warhead—greatly increasing nuclear yield.

New Rockeye Missile for Navy

Navy's *Rockeye* missile, a free-fall cluster bomb with a number of small conventional warheads wrapped around the rocket motor, may be funded in the FY '64 defense budget. Initial R&D on the missile was performed by Ryan Aeronautical Co. under a 1961 design contract calling for building of several prototypes. Funds in the '64 budget presumably would be to complete development.

No Way to Collect for Hyphen

NASA officials say there is no way they can collect $18.5 million for the error which is blamed for failure of the first *Mariner* launch on July 22. NASA has attributed the error to omission of a hyphen from the ascent guidance equation prepared by Space Technology Laboratories. The mistake could add fuel to the drive of certain Congressmen who want to require performance bonds from contractors in the space program.

Compromise Seen on NASA Funds

The Senate is expected to restore approximately $50 million of the $100 million House-approved cut in NASA's fiscal '63 appropriations bill. If past tradition holds, the two chambers then will split the difference, for a total reduction of $75 million.

INDUSTRY

Firebee May Be Firefighter

Ryan Aeronautical's *Firebee* target drone is to be tested in the Mojave Desert by the U.S. Forest Service. Purpose: to determine the drone's effectiveness as a weapon against forest fires. *Firebee*—carried aloft and dropped by a modified B-25 or B-26—could fly over a burning area to spread flame-retarding chemicals over the blaze.

New Profit Fee Study is Due

Changes in profit and fee policy in defense contracting are to be recommended by the non-profit Logistics Management Institute within the next three or four months. The study was instituted by Department of Defense after Senate hearings earlier this year on so-called profit pyramiding.

New RCA Communication Proposals Due

Watch for considerable controversy over a speech by RCA Board Chairman David Sarnoff, scheduled before the American Bar Assn. in San Francisco this week. He will propose major changes in the nation's international communications setup which could affect communications satellites.

Another Blow to AFA Exhibit

One of the major aerospace firms, in addition to cancelling plans for an exhibit at the Air Force Assn. convention in Las Vegas, has forbidden employees in any of its divisions to attend the AFA meeting.

INTERNATIONAL

British to Replace Thor Missiles

Britain will replace Thor missiles based in England with Douglas *Skybolt* air-to-ground missiles mated to Vulcan jet bombers. This means U.S., which controlled *Thor* nuclear warheads, will lose major role in Britain's deterrent force. RAF *Skybolt* will have a British warhead.

BAC May Build Nord AS-30

British Aircraft Corp. and Nord Aviation have signed an agreement for joint research, development and production of guided missiles. This means BAC may build the French AS-30 under license to fill the recent RAF order for the air-to-surface missiles.

Shots of the Week

A *Thor* missile carrying the fourth in a series of nuclear devices for detonation at high altitudes was destroyed on its Johnston Island launch pad July 26. It marked the third failure in four attempts for the high-altitude test series. The only success was achieved on July 9, when a nuclear device of more than one megaton was detonated some 200 miles over the Pacific.

"No injuries to personnel and no hazard from radioactivity" resulted, according to the joint AEC-DOD announcement. Fires fed by the rocket fuels, however, were reported to have damaged the launching area so badly that it would be six to eight weeks before another test could be scheduled. The refurbishment time on previous launches has been about two weeks.

The announcement indicated that the high-explosive parts of the nuclear device were not detonated but allowed to burn after the missile had been destroyed. Specifically, the announcement cited "deliberate destruction and burning of a *Thor* booster and nuclear device." Detonation of the high explosive, official sources said, would have spread radioactive material over wide areas of the launch site.

Last week, a joint AEC-DOD announcement made it clear that the U.S. intends to continue the nuclear test series—thus squelching rumors that the test would be terminated to meet President Kennedy's announced deadline and to avoid testing concurrently with the expected Soviet test series.

• The Air Force had its first successful launch of the *Atlas F* raised from an underground silo on Aug. 1, when the 90-ft. missile roared some 5000 miles down the Pacific Missile Range from Vandenberg AFB. For the test, silo doors were opened 90 seconds before launch, and the missile raised to firing position.

• A two-stage *Caleb* rocket probe was successfully launched from a jet air-craft over the Pacific Missile Range at Pt. Mugu, Calif., July 25. The 150-lb. scientific payload—part of a series of inexpensive air-launched high-altitude probes designated Project Hi-Hoe—attained an altitude of 1000 miles. The probe was designed to measure the ion composition of the Earth's upper atmosphere.

• A *Polaris A-2* missile carrying components for the more advanced *A-3* model was destroyed after launching from a land pad at Cape Canaveral July 26. Failure of the second stage caused the missile to veer off-course before it was destroyed by the range safety officer.

• Pilot Neil Armstrong—already scheduled to become an astronaut—piloted the *X-15* to an altitude of 100,000 ft. and a speed of 3,954 mph before beginning a series of *X-20 (Dyna-Soar)* type re-entry and landing maneuvers July 26. Armstrong piloted the *X-15* through a series of up and down maneuvers with his yaw adapter deliberately turned off to see whether man can successfully bring a spacecraft back to earth by himself. Using only manual controls during the descent, Armstrong said after the flight that "a pilot can control a ship during re-entry without electronic controls if such an emergency arises."

• *Cosmos VII*—the latest in the Soviet's unmanned space research satellite series—was successfully launched, July 28, according to a TASS news agency announcement. Although the weight of the satellite was not given, the announcement said *Cosmos VII* was in an elliptical orbit with an apogee of 229 miles, a perigee of 130 miles and a period of 90.1 min.

• Premier Khrushchev reportedly watched the first firings of a Soviet *Polaris*-type missile, July 21, in the Arctic Ocean. The missiles were said to have been fired from submerged submarines.

• A *Jupiter* IRBM was successfully fired by a team of Italian air force troops at Cape Canaveral on Aug 1.

MMRBM Study Contracts Let

Fourteen firms were named by the Air Force last week to conduct further studies on the *Mobile Medium-Range Ballistic Missile*—a missile originally described by AF as "well within the state of the art."

Although the announcement of the contract plans is a step forward in the program definition phase, fate of the *MMRBM* still is uncertain. No decision has been made on a production program, although AF said the new studies were leading to preliminary design, cost estimates and production planning.

The companies selected were: integration, assembly and checkout, Hughes Aircraft Co. and Northrup Corp.; re-entry system, Ford Aeronutronic in association with Fairchild Stratos Corp., Sperry Rand Corp. and Avco.; propulsion, Rocketdyne Div. of North American Aviation and Thiokol Chemical Corp.; transporter-launcher-erector, American Machine & Foundry Co. and Goodyear Aircraft Corp.

Command and control, Hughes Aircraft Co. and Martin Co. in association with Sylvania Electronic Products, Inc.; guidance and control, General Precision, Inc.

MIDAS Trouble Confirmed

Air Force General Bernard Schriever told a congressional subcommittee that development of *MIDAS* "will take longer than we forecast."

Confirming an M/R report (July 16, p. 12) that the satellite system was in serious development trouble, Schriever indicated that there have been problems involving the satellite's reliability and "certain technical features I can't talk about for security reasons." He made his remarks last week before a House government operations subcommittee which is studying the use of scientists in government.

Kindelberger, NAA Head, Dies

J. H. (Dutch) Kindelberger, chairman and chief executive officer of North American Aviation, Inc., Los Angeles, died July 26 in his Pacific Palisades, Calif., home. He was 67, and had been NAA head since 1948. *(See editorial, p. 46.)*

AMC Streamlines Army

Establishment of the Army Materiel Command Aug. 1 is expected to simplify and hasten the task of converting major weapons system plans into operational hardware.

Lt. Gen. Frank S. Besson, Jr., is shaping his new command along the "project manager" lines of the Navy (responsible for *Polaris's* short lead time), and the Air Force's "red line" procedure. AMC has assumed the research, development, production and

distribution functions of the old technical services—Quartermaster, Ordnance, etc.

In all, 30 priority programs warrant project managers under the streamlined AMC setup. Among these is *Nike-Zeus*. Others whose chiefs will report directly to Besson's Washington office include field Army ballistic missile defense, light observation helicopter, *Shillelagh* missile, arming of Army aircraft, Mohawk surveillance aircraft, Caribou battlefield transport, and *Advent* satellite ground stations.

Exhibitors Dwindling Away

Industry participation in exhibitions is continuing to decline, according to latest returns of an Aerospace Industries Association poll, dated July 10.

Hardest hit has been the Air Force Association convention, scheduled this year for Las Vegas. Only nine firms polled indicate an intention to exhibit, compared to 26 last year, a decline of 17.

Participation in exhibitions by technical societies also continues to fall off. Fourteen firms indicate an intention to exhibit at the American Rocket Society meeting against 25 last year. Society of Automotive Engineers has fallen from 11 to 3.

Institute of Radio Engineers fell only 16 to 14 and the American Society of Mechanical Engineers shows a minor gain from 3 to 4.

Congress Passes Defense Bill

A compromise Defense Appropriations bill for FY '63—totalling $48,136,247,000, some $229,247,000 more than President Kennedy requested—was approved by the House and Senate last week and sent to the White House.

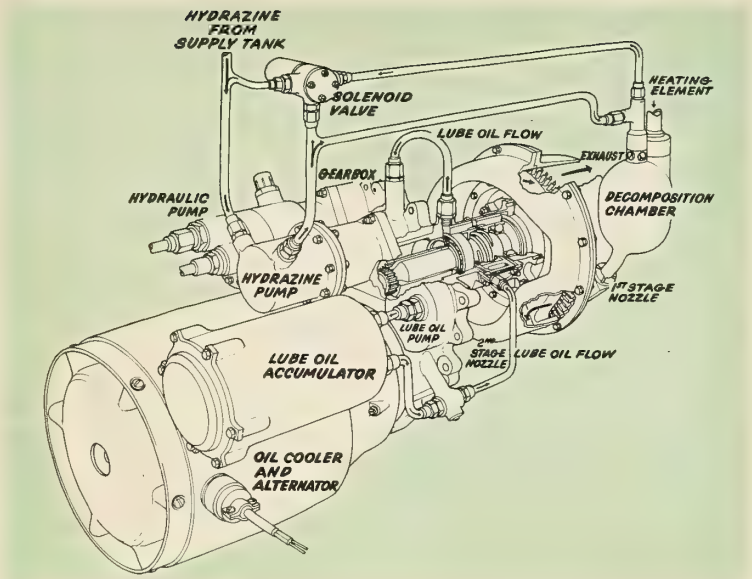
Increases over the President's initial request included $191 million for the development of six RS-70 prototypes, bringing to $362,600,000 the funds for the supersonic aircraft.

The *X-20* budget was increased by $42,000,000 over the $115,000,000 asked by DOD.

C-1 Contract Signed

NASA announced the signing of a $125.5-million contract with the Chrysler Corp. for production of 21 *Saturn C-1* first-stage boosters. The award covers a period from Aug. 1, 1962, to Dec. 31, 1966.

The space agency also signed a $7.1-million contract with Chrysler for equipment needed to carry out the prime contract.



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'Flexible spacecraft' . . .

NASA May Stretch Gemini to 5 Years

Special propulsion capability with Agena B makes craft highly adaptable for future uses

by Hal Taylor

NASA MAY EXPAND its Project *Gemini* two-man spaceflight program from two to perhaps five years.

The additional flights would be primarily concerned with scientific experiments, but additional manned orbital flights beyond the currently planned 12 may be included.

The possibility of an expanded program was revealed by Col. Daniel McKee, Director of Project *Gemini* in NASA's Office of Manned Space Flight.

"We are coming up with a reliable and flexible spacecraft which has a lot of potential for scientific investigations of space," McKee told MISSILES AND ROCKETS. "If additional applications develop, it would be used for various purposes."

"Personally, I think it will be used in the U.S. space program for the next four or five years."

NASA now plans a three-phase, 12-flight program, with the primary goal a one-week-long manned mission and the testing of orbital rendezvous operations.

Its timetable calls for the first flight in mid-1963, but slippage is already creeping into the program. It now appears likely that the first manned flights will not be made until 1964.

The three-phase program calls for:

—*One unmanned test flight*—No decision has been made as to whether it will be ballistic or orbital or how long it will last. If an orbital flight is made, it will have a maximum duration of one day.

—*Long-duration manned flights*—Three flights are scheduled. This will call for a gradual extension beyond one day with a primary goal of one-week-long flight. The spacecraft has a two-week mission capability, but NASA does not now plan such a flight.

—*Rendevous operations*—Eight flights are scheduled; all will be manned. During the first flights the propulsion systems of both the spacecraft and the *Agena B* target vehicle will be used to achieve rendezvous. Later it will be attempted with only the spacecraft propulsion. In the final flights, the *Agena B* propulsion system will be fired as soon as rendezous docking has been completed.

• **The big attraction**—It is this latter capability which makes *Gemini* especially adaptable to future manned and unmanned missions both for scientific exploration and the further study of rendezvous.

Once the rendezvous has been made, the *Agena B* propulsion can be fired to provide the thrust to change the orbit of the spacecraft. This would permit very high orbital-altitude flights or even the inspection of other orbiting space vehicles.

There have been reports that the spacecraft might be used for a circumlunar mission. Because of its early development, such a flight with *Gemini* could be made as much as two years earlier than similar flights planned for Project *Apollo*. Informed sources now report, however, that this is not being seriously considered.

It is apparent that additional flights for *Gemini* have already been proposed. Some of these could include sending a man along to monitor onboard scientific instrumentation.

Expansion of the program will mean an increase in its announced overall cost of $500 million.

McDonnell Aircraft Corp. is prime contractor for the spacecraft. Thus, far, McKee said, development has been coming along very well. Completion of the first mockup spacecraft is due this month.

McKee also declared that while flight plan calls for a tight schedule, a launch every two months is not unreasonable.

Only one *Titan II* pad at Cape Canaveral will be modified for the program. Thus, if the launch site is damaged at any time, long delays would result. ⌘

AF Awards Contract for Space Crew Study

THE AIR FORCE moved a step further into the manned spaceflight business last week with the award of a study contract to the Aeronutronic Div. of Ford Motor Co.

No dollar value for the contract was disclosed, but it calls for a one-year study to "isolate, identify, define and code tasks and skills" that will be required by members of future aerospace crews.

James C. Elms, director of electronics at Aeronutronic, said the program will be conducted by the Human Factors Engineering Section of Electronics. Project manager is Dr. Herbert A. Berry.

Paul Horowitz, of the Human Factors Engineering Section, has been assigned by Aeronutronics to the AF's Behavioral Science Laboratory at Wright-Patterson AFB, Dayton, Ohio, where the study will be conducted, to work with AF personnel. The lab is part of the AF's Aerospace Medical Division.

Examples of advanced systems that may be studied, Elms said, include recoverable boosters, strategic orbital systems, space planes, and space logistics, maintenance and rescue systems.

In Systems Command . . .

AF Research & Technology Division Now Operational

Consolidation follows DOD urgings; organizational phase ends July '63

by James Trainor

PENTAGON PRESSURE to consolidate military laboratories and bring research and technology under a single manager was a major factor in the establishment of the Air Force Systems Command's new Research and Technology Division.

Maj. Gen. Marvin C. Demler, commander of the R&T division, noted in an interview with MISSILES AND ROCKETS that the Army had also undergone a sweeping reorganization of its laboratories to comply with the desires of the Defense Department. He said the Air Force's task was easier, however, because it had already been moving in the direction of consolidation.

In fact, Demler said, the Research and Technology Division represents another step in the evolution of the AFSC management structure. Demler noted that concern began to grow within the Systems Command last year over the attention or lack of it that might be given to research and technology as contrasted to the emphasis placed on systems development.

As a consequence, in the fall of 1961, research and technology was made a staff responsibility within AFSC, under a Deputy Chief of Staff for Research and Engineering. From this nucleus, the Research and Technology Division was provisionally activated on April 4, 1962, and became operational on July 26.

The organizational phase is scheduled to be completed by July 1, 1963.

• **What is it?**—Essentially, the Division will manage the applied research and applied technology programs of the Systems Command by providing centralized planning and direction to the laboratories under it. At present, Demler noted, this includes some 30 laboratories scattered throughout the Systems Command and the management of some 27 technical areas.

Between now and next July 1, he said, the main task of the division will be to re-structure the lab management in order to get the technical areas matched up with a smaller, but technically stronger, number of labs.

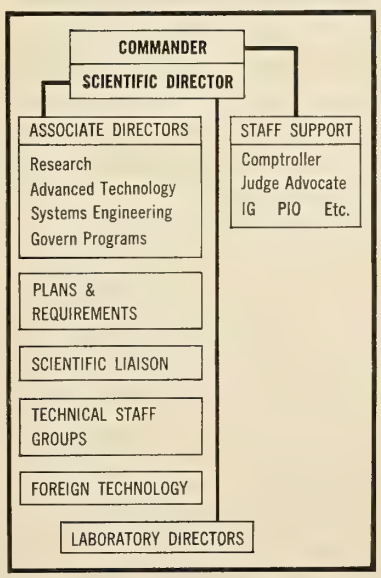
The Division will have cognizance over all the laboratories except those assigned to the Aerospace Medicine Division and the Air Force Office of Aerospace Research.

Housed at the AF's Bolling Field in Washington, the Division has a total strength of 70—55 from the former DCS/R&E staff and 15 added since the provisional activation in April. Most are technical program monitors with staff support being provided by AFSC Headquarters at Andrews AFB.

The Division staff probably will grow to 100, Demler said.

One of the anticipated benefits of the R&T division, he noted, would be the gradual phasing out of several layers of staff between the labs and the R&T Div., freeing technically qualified people to return to the labs. The idea is to have the lab directors work directly with the Division, he said.

The magnitude of the Division's responsibilities is reflected by noting that in the current fiscal year the Air Force's Applied Research program is funded at $255 million; advanced technology, about $176 million; independent industrial research program, about $100 million and ARPA work, $30 million. In addition, although funding figures are difficult to pinpoint, about 10% of in-house effort is expended in these areas.



R&T division's organizational chart.



Maj. Gen. M. C. Demler
. . . more challenging jobs

To effectively manage the R&T program, General Demler will have a Scientific Director under him. Reporting to the Scientific Director will be eight associate directors for research, advanced technology, systems engineering, program management, plans and requirements, scientific liaison, technical staff groups and foreign technology.

• **What about labs?**—Although the number of laboratories within the division probably will decrease, Gen. Demler stresses that the change is basically designed to strengthen the lab effort.

Noting that both the Bell and the Federal Council on Science & Technology reports—endorsed by President Kennedy—emphasized greater government in-house capability, Gen. Demler said that the re-constituted labs will have improved facilities and more challenging jobs. They also will be considered the AF center of expertise in their particular specialty.

Rather than being down-graded, he noted, lab chiefs will be upgraded and will have the basic responsibility for formulating programs in their technical area. In addition, they will be accorded the prerogatives of re-programing or altering objectives within an approved program. Procurement regulations—designed more for maintaining a base logistics setup than for procuring scientific equipment—may be modified to give the lab chief the authority to buy

(Continued on page 37)

10-year satellite program . . .

$1 Billion Sought for Weather Study

Weather Bureau wants two polar-orbiting Nimbuses, four Aeroses for uninterrupted scrutiny of Earth

by Heather M. David

PROPONENTS OF meteorological satellites are pushing for a program that will cost about $1 billion in the next ten years.

A committee asked by Presidential science advisor Dr. Jerome B. Wiesner to establish national goals in the atmospheric sciences has suggested a budget of $400 million for satellite development in the period. But spokesmen for the official program described this estimate as "low."

The committee figure itself tops the operational systems expenditure, which will probably run around $50-60 million a year.

Prime goal in meteorological satellite development is the *Aeros* concept. Study contracts will be let in September, says NASA's director of meteorological systems, Dr. Morris Tepper. More than one contract will be let if several companies show qualifications, Tepper added, since there are a number of problems in the synchronous meteorological satellite concept. Bids were received July 23.

• **Operational system**—The new chief of the Weather Bureau's Meteorological Satellite Activities, Dr. S. Fred Singer, outlined for M/R what the Bureau is envisioning for its operational system:

—Two *Nimbus* satellites in polar orbit, at all times. Each will probably have an average lifetime of about six months, requiring three launches a year.

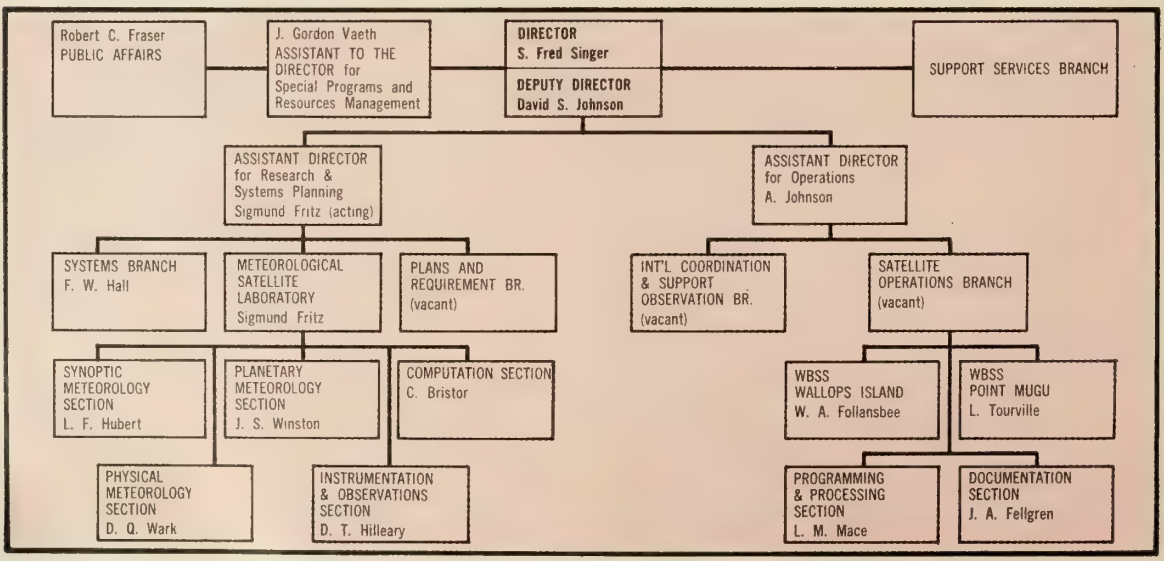
—Four *Aeros*-type satellites in 23,000-mile, synchronous orbit at the equator. These would permit complete, continuous coverage of the Earth up to the polar regions, complementing the *Nimbus* system.

Tepper said that when study contracts are turned in—around the first of the year—another contract will be let on the major problems defined. Development of long-lead-time hardware may begin at this time, he indicated.

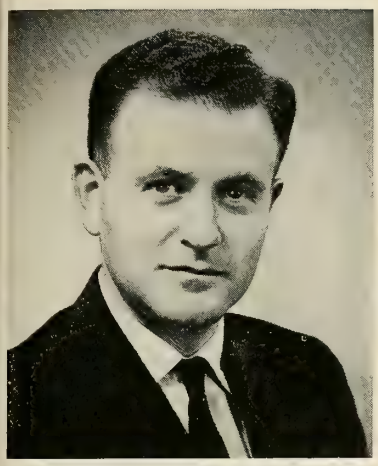
Development of the *Aeros* satellite probably will be affected by the delays in the *Centaur* program. *Centaur*, regarded as a possible launch vehicle, is now running about two years behind schedule, although NASA officials contend it will be ready as planned in 1964.

Singer said the goal of the meteorological satellite program is to "get a continuous look at every point on Earth." Eventually, MSA will administrate a program of instrument-bearing ocean buoys and balloons to gather temperature, wind, surface-state and pressure data. These will be transmitted to satellites, which in turn will relay information to data-processing centers.

MSA is in the midst of a $10-million construction program for the *Nimbus* data-processing center underneath present facilities at Suitland, Md. This center is expected to be sufficient to handle *Aeros* data as well.



ORGANIZATIONAL CHART of Meteorological Satellite Activities (MSA) section of the Weather Bureau.



MSA's S. Fred Singer

Calls his Meteorological Satellite Lab the "most productive in the world."

Areas of prime interest to the Weather Bureau for its ultimate program are reliability of sensors, storage devices, spacecraft systems such as attitude stability and telemetry.

Already under development at the Meteorological Satellite Laboratory is an infrared spectrometer for satellite use which will give virtual "3-D" information about the atmosphere. This sensor will measure temperature along the vertical, information not available by any other means. Barnes Engineering Co. is developing a balloon flight model under a one-year contract of $314,000.

There will be three balloon test flights of the spectrometer before it is refined and incorporated into the *Nimbus* program, probably after *Nimbus 3*.

Another project of interest at the Lab is a study of sferics, or the radio frequencies of lightning. IBM holds a contract to record data which will be used in developing equipment for satellite-borne measurements of these unique phenomena.

The Lab, which employs 40 people, is described by Dr. Singer as "the most productive in the world." Some of the research now being done is into the physics of tropical storms—an investigation which can be done only with satellites. One day, the lab will strive to develop a way to affect or divert these storms.

Another side benefit of the meteorological satellite has been photographs of ice cover, which indicate when ice sections will melt. Lab researchers are trying to determine exactly how to predict this.

• **Contracting** — Most contracting done directly by MSA is in the basic research field—mostly to universities or companies with proven competence in basic research. The agency prides itself on its "uncomplicated" approach to contracting. Singer attributes this to his academic background (Professor of Physics, University of Maryland) coupled with assistant J. Gordon Vaeth's industry background.

The agency requires only one copy of each proposal and no proof other than a man or company's record as example of his worth.

MSA contracts for systems studies, technical studies, description and construction of instrumentation, systems research, data processing, recording equipment and display equipment.

Funds are transferred to NASA for command and data acquisition stations as well as for spacecraft. In the present *Nimbus* program, the Weather Bureau is funding two spacecraft to supplement the four R&D spacecraft NASA originally planned. This will insure complete coverage and operational use during the research period.

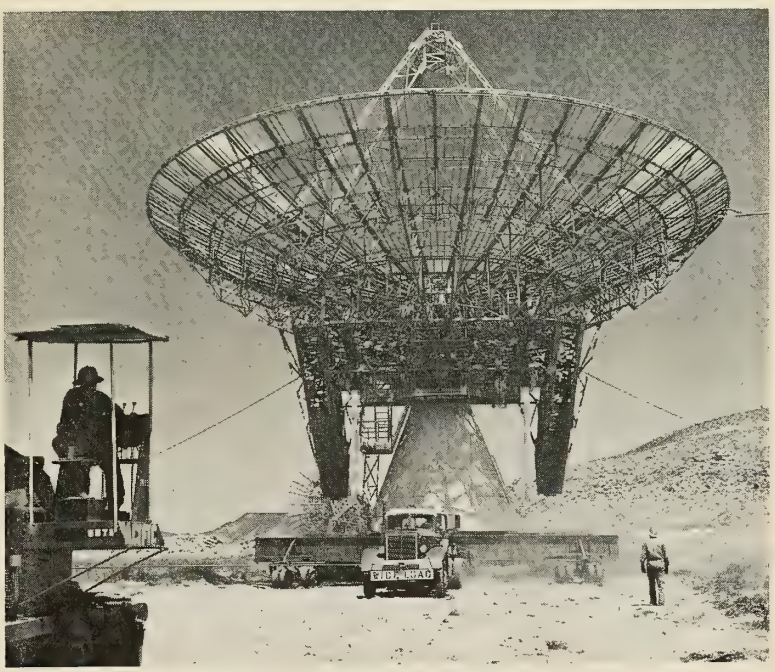
Although NASA is not required to accept recommendations of the Weather Bureau in the research period of the meteorological satellite systems, the two agencies have worked closely together. One of the chief jobs of MSA in this period is to find out from its own clients what requirements they will have, so that they will be filled by the operational spacecraft.

Best customer of the satellite information center is the Department of Defense, which requires global coverage. In addition, all international airports in the country are being supplied with *Tiros* information to aid civilian flying.

Although most satellite information is sent coded or on a telephone fascimile system, it can also be provided by real-time, in which the pictures are actually transmitted directly to the receiver. The Australian Weather Bureau recently became the first recipient of this method.

• **Other recommendations**—The National Academy of Sciences Committee on Aeronomy, which drew up the $400-million research budget proposal, also made recommendations for use of meteorological satellites.

Areas suggested for the interim period before the satellite system becomes operational are: descriptive dynamical studies of large-scale motion systems, research on synoptic and other aspects of infrared radiation, studies of heat balances and the development of methods for interpreting satellite photography in terms of the physical and dynamical characteristics of the atmospheric systems. ⌘



FIRST RELEASED PHOTO of Nimbus ground telemetry station, which will receive, process and display pulse code modulation (PCM) telemetry data from the Nimbus weather satellite. The station was built under the technical direction of NASA's Goddard Space Flight Center by Radiation Incorporated, Melbourne, Fla.

Full stream by October . . .

Giant Motor Plants for Minuteman

Thiokol-operated first-stage plant, Hercules-run third-stage facility dedicated in Utah; AF spokesman presses for more launch sites

by Richard van Osten

SALT LAKE CITY, UTAH—Two huge production complexes for the first and third stages of the Air Force's *Minuteman* ICBM will be in full operation here by early October.

Both facilities were dedicated recently—Air Force Plant 78 operated by Thiokol Chemical to produce *Minuteman* first-stage engines, and Air Force Plant 81 operated by Hercules Powder to turn out the third stage. The Thiokol operation is near Brigham City and the Hercules site near Bacchus.

Equipment in both plants is now being checked out; some units will be on a production basis within 45 days.

At least one more *Minuteman* site is due for selection this Fall, depending upon Department of Defense action. The Air Force has expressed its belief that many more than the presently planned 800 units will be needed. Or, as Brig. Gen. Samuel C. Phillips, deputy commander for *Minuteman,* Air Force Ballistic Systems Division, puts it: "I personally believe we should have several hundred more."

Speaking at the dedication, Gen. Phillips said DOD will add what it believes necessary in additional *Minuteman* installations as construction lead time comes up.

He also indicated that at least one additional site will be named each fiscal year until the desired strategic strength is acquired.

Citing the relatively low cost of the *Minuteman* system, Phillips said the concept has an acquisition cost ratio of 5 to 1 over other strategic systems, and an operational cost ratio of 10-1.

• **Facilities spread** — Plant 81 has 97 separate buildings on a 540-acre site. Present employment level at the overall Hercules facility is about 5500, with an increase to 6500 planned during the next 12 months. Approximately 1500 people are directly involved in the *Minuteman* program. Hercules also produces the *Polaris* second stage at its Utah plant, but the AF facility is solely for *Minuteman.*

Plant 78 has 112 buildings on a 1500-acre site. Total employment between AF Plant 78 and Thiokol's R&D center is approximately 6000 persons. AF Plant 81 represents an investment of some $15 million—Plant 78, an investment of slightly over $25 million against an original budget figure of $29 million.

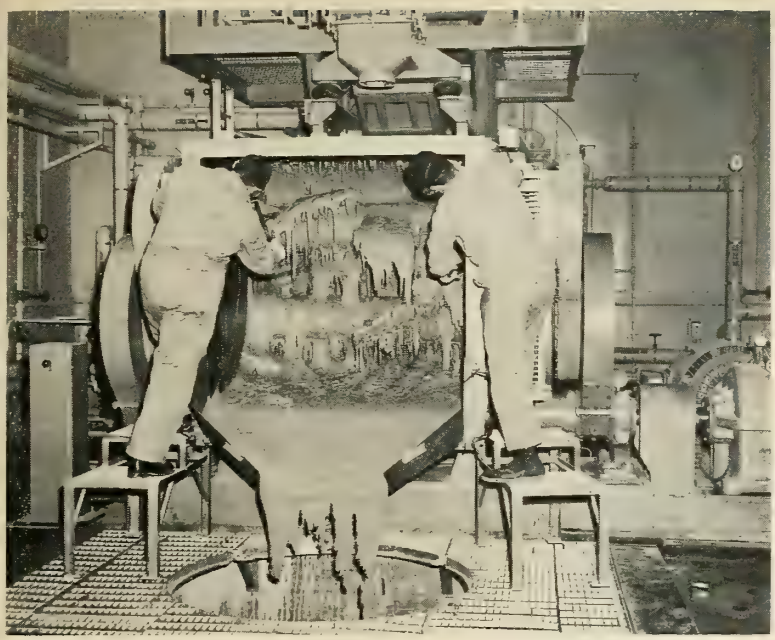
Both plants can handle much larger solid-propellant motors, but there is little evidence that such projected sizes as 240 and 260-in. motors could be run through on a production basis without some very major modifications.

• **Top I_{sp} claimed**—The Hercules-operated Plant 81 is well-equipped, but with somewhat smaller mix and cure facilities than Plant 78. Plant 81 mix and cure buildings are highly banked with earth revetments to meet Armed Forces Explosive Board safety requirements. The third-stage *Minuteman* motor uses a double-base propellant composed of aluminum and ammonium perchlorate in a nitrocellulose-nitroglycerin binder. The mix produces the highest specific impulse measured to date, the company claims.

The case is Spiralloy, a glass fiber base material developed by Hercules.



ROWS OF CASTING BUILDINGS at the Thiokol-operated facility are capable of handling the largest solid motors in production.



FIRST BATCH of propellant mixed at AF Plant 78 pours into transfer can. It is then loaded into Minuteman first stage at one of the casting buildings.

The filament-wound, resin-bonded units for *Minuteman* are produced at the company's facility in the Clearfield Naval Supply Depot, Clearfield, Utah. The third stage case has over 188,604 miles of continuous glass filaments.

The Hercules process is somewhat different than that for the other stages. The dry ingredients are mixed then "blended" by means of a solvent which is poured into the dry mix and allowed to "drip" throughout the mix. Casting, however, is done within the case, and the propellant is bonded directly to the case wall.

The third-stage curing process requires 16 days at 120°F. Final-stage propellant load tolerance is ± 12 lb.

There is little similarity between the two facilities other than that they both make *Minuteman* stages. The different processes involved demand different facilities.

• **Automated mix** — Probably the most "different" feature of the Thiokol-operated plant is the automated batch mixing process developed jointly by Thiokol's Wasatch Division and Toledo Scale Corp. (M/R, April 5, 1962, p. 36). The system, based upon large-scale production techniques for high-quality glass in that industry, is designed to produce motors in which each propellant batch is identical in physical and ballistic characteristics to every other batch. The process also is said capable of reducing raw materials handling by some 80%.

Developed at a cost to Thiokol of $350,000, the ABM process uses a combination of three facility installations. Each remote system is operated from a facility control board programmed through a digital computer. The computer maintains the board's accuracy and circuitry on a go, no-go basis.

A series of automatically typed propellant processing logs are prepared at panel control stations remotely monitoring each facility. The weighing accuracy normal to industry prior to ABM's introduction was a detected error of 3 lbs. per 1000-lb. batch. The present system reports errors of 2 oz. when weighing quantities of 4000 lbs.

Besides the handling reductions, ABM also exerts a positive reduction in waste by preventing inadvertent mixing of off-tolerance batches.

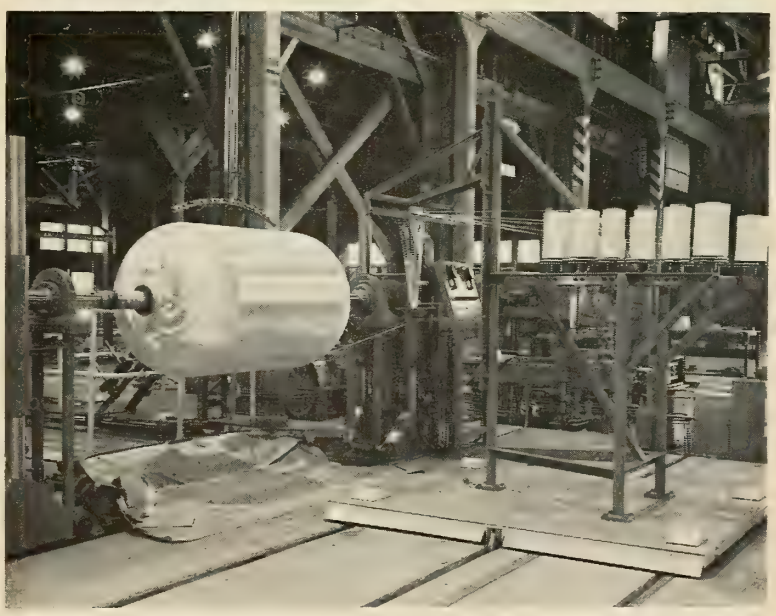
Based upon the philosophy that "if you don't lift it, you can't drop it," AF Plant 78 is also equipped with a system of rails and hydraulically operated tilt tables for transportation and positioning of motor cases during production. The rail system is used also in mixing and curing buildings. The large vacuum bells, where casting and curing is done, tilt for motor-case loading on the rails which extend into the vacuum chamber.

Transfer is made directly from a vehicle with rails to the chamber which tilts to a full horizontal position. The chamber is then tilted back to the vertical position below the propellant mixer, and the case is loaded. Curing is done at 135°F for 120 hours.

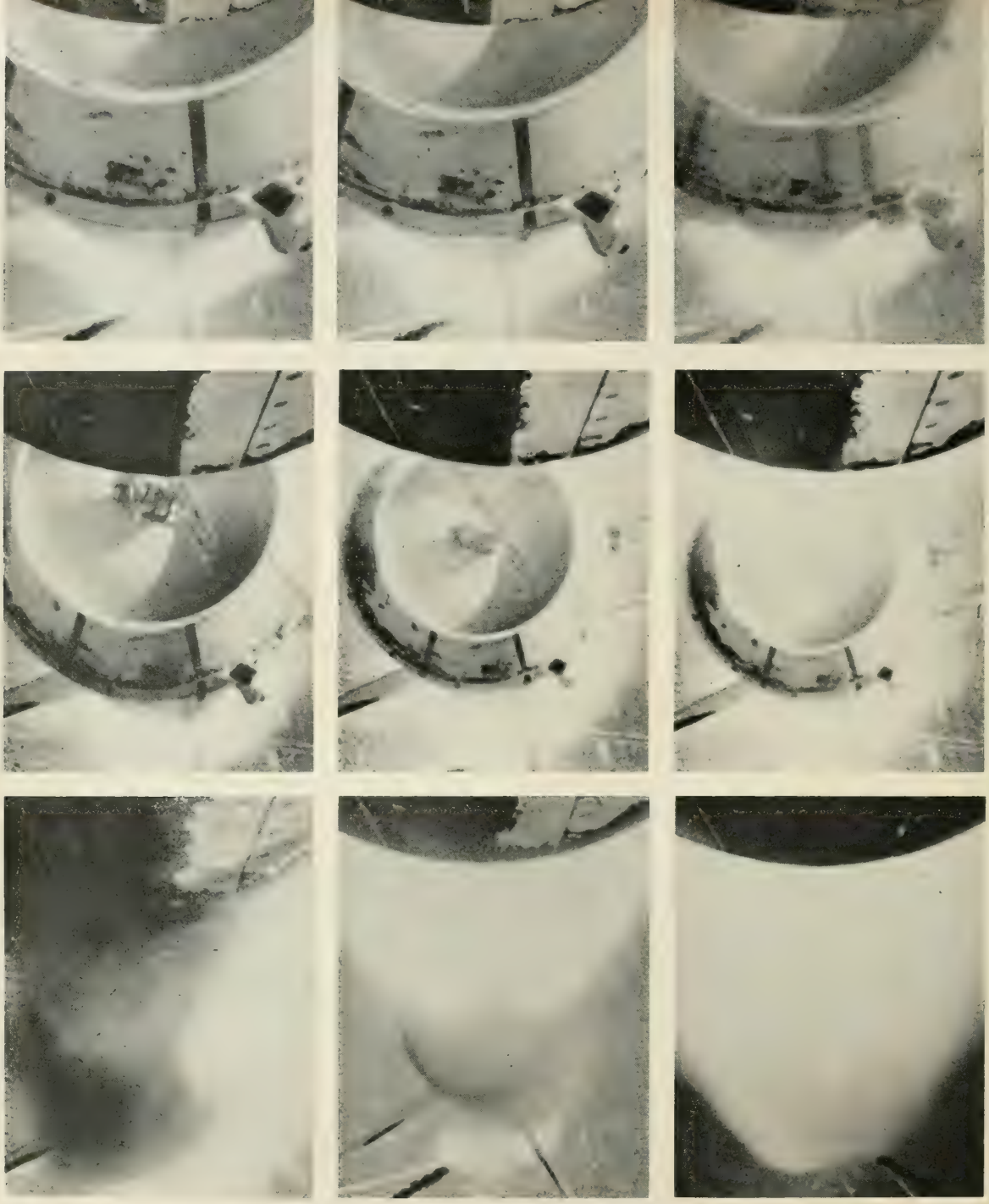
Remote-control TV is used extensively in both plants where hazardous operations are involved. Thiokol's core-pulling process is all done remotely for safety reasons. All Hercules mixing and curing buildings are equipped with remote TV for several phases of processing.

Both plants also use electronic-type inspection systems for quality control. Thiokol has two 13-million-electron-volt linear accelerators for inspection of fully-loaded motors.

Plants 78 and 81 represent the latest in solid motor production facilities, but room for expansion and modification to meet future AF requirements has been built in. ⁂



HERCULES PRODUCES third-stage glass cases at its Clearfield, Utah, facility on winding machines such as those shown here.



Nike-Zeus Booster Separation Filmed

FIRST-STAGE BOOSTER falls away as the second stage ignites during a recent test of the Army's Nike-Zeus antimissile missile. The bulky unit, developed by Thiokol Chemical Corp., attains more than 400,000 lbs. thrust during its extremely short firing life. The Zeus intercepted an Atlas warhead over the South Pacific last month in its second launching against an ICBM target. The first test was not a complete success, says the Pentagon, but the program will proceed towards more sophisticated targets. The Zeus effort continues on a development basis while a dubious DOD contemplates its $10-billion installation pricetag and wonders about its effectiveness against saturation attacks and decoys. Film sequence is from "The Solid Punch," a U.S. Army/Thiokol documentary being shown at bases around the world.

Technical Countdown

ELECTRONICS

Photos Digitally Analyzed and Copied

Satellite-viewed cloud-cover photo intelligence can now be converted to digital form by a technique recently announced by IBM. The data can be reconstructed and reproduced as a Mercator projection. Sponsored by the Geophysics Research Directorate of the Air Force Cambridge Research Labs, the approach makes possible for the first time the production of composite cloud maps covering large land masses—up to continent size. Starting with 35-mm film, the photos are scanned electronically and variations in shading are categorized numerically from 0 to 7. Points are grid-located in true Earth coordinates for reconstruction.

Hardened C&C For Minuteman Ordered

Under a recently awarded $2-million contract, Sylvania Electric Products, Inc., will develop an advanced command and control system for the Air Force *Minuteman* weapon system complex. This is the first increment of what is expected to be a long-term R&D program. Awarded by the AF Ballistic Missile Division, the contract includes the design and development of blast-resistant communications stations comprising the primary network and a backup net to insure command security and availability.

New Microdensitometers Developed

Scientists at the Geophysics Corp. of America are building three self-recording microdensitometers for MIT's Lincoln Laboratory which are said to be capable of extremely precise linear measurements in (x, y) coordinates. The instruments reportedly also are capable of accurately measuring photographic-emulsion densities in the range of 0-5 density units. (In terms of percent of light transmitted, density of 5 corresponds to 0.001% transmission.) Two of the three units will be used to gather ballistic missile data for Project PRESS (Pacific Range Electromagnetic Signature Studies). PRESS is being directed by DOD's Advanced Research Projects Agency.

Tracking Site Reactivated

The new tracking facility at Point Pillar, Calif., for the Pacific Missile Range will be managed by the Naval Missile Facility, Pt. Arguello, Calif. To be known as the Pt. Pillar Auxiliary Station, the installation will be operated on contract by Federal Electric Corp. personnel. Originally built in 1959 as a *Regulus II* control station, the facility was deactivated following cancellation of that missile program.

ASTRONAUTICS

Solar Simulators Still Inadequate

Industry generally seems to remain skeptical of available solar simulators. The approach favored is continued collection of data from balloon-borne instrumentation. These data would be used to establish firm laboratory standards and to calibrate existing simulators. Many experts say they are convinced that more data are needed in many areas, such as the characteristics of unfiltered sunlight. Information such as this, they say, cannot be obtained or extrapolated from ordinary terrestrial studies.

ONR to Map Near Sky

First assignment of the Office of Naval Research's 85-ft. radio telescope at Hat Creek, Calif., will be the mapping of our visible galaxy. The accent will be upon studies of the gaseous hub at the center. The antenna, to be operated by the University of California with support from ONR, has been especially designed to study emanations from hydrogen clouds. A future project will include studies of such clouds as remnants of supernovae.

PROPULSION

UTC Test Stand Ready

Static firings in the 120-in. solid booster program at United Technology Corp. will be handled in a new test stand at the San Jose test site. The complex will take engines up to 2 million lbs. thrust. The firm reportedly is considering production sites in Florida and Georgia for the 120-in. program. The reason—displeasure with local restrictive laws in the San Jose area. Final approval rests with the Air Force but UTC recommendations would probably be accepted. Production of the 120-in. booster is still some 3 years away.

More on Minuteman

Hercules Powder and the Air Force are looking at the possibilities of switching to a slurry-type process for the *Minuteman* third stage. The process would replace the present Hercules mixed-dry-powder-plus-solvent method. The second *Minuteman* wing probably will use a cork-type ablating coat on its third stage and in some interface areas. Construction contracts for the *Minuteman* installation at Warren AFB are expected within 90 days.

Rocketdyne Runs 150,000th Test

Rocketdyne's Propulsion Field Lab, near Los Angeles, has completed its 150,000th test in 12 years of engine development. Almost 22,000 tests have been made with engines of over 50,000 lbs. thrust; 6810 large thrust chambers have been tested; and 121,267 tests of components for larger engines have been covered.

ADVANCED MATERIALS

GSE Standards Published

A new Air Force military standard, MIL-STD-810, Environmental Test Methods for Aerospace and Ground Equipment is being distributed by the Commander, Wright-Patterson AFB, Ohio, Attn: EWBDSR. The standard establishes uniform test methods for determining the effects on aerospace and ground equipment of the natural and induced environments encountered in military service. The 18 test methods specify laboratory conditions designed to produce results similar to field conditions.

Environmental Test Lab Opens

General Time Corp. reports it is now operating a complete environmental test lab with capabilities covering both military and industrial applications. The equipment includes the latest models of units to test the effects of shock, vibration, temperature-altitude and temperature-humidity.

Simulator To Determine Lunar Surface Nature

Spectroscopic data on the lunar surface gathered by rockets and balloons will be duplicated by the Air Force with an Ilikon Corp. instrument capable of vacuum down to 2×10^{-10}, ultra violet, X-ray and alpha particle radiation. Data from both real and simulated sources will be constantly compared.

Set for early '63 . . .

S-66 Will Chart the Ionosphere

Project calls for unprecedented international cooperation; laser-tracking may get first test

by William Beller

THE FIRST MAJOR step toward a global map of the ionosphere is scheduled for early next year when the *S-66 Polar Beacon Ionosphere Satellite* goes into orbit.

The project is almost certain to enhance communications theory. It probably will produce a corresponding advance in communications equipment.

The satellite will carry experiments expected to bring about a world-wide participation of scientists—more than any previous space effort. One hundred and fifty geophysical stations scattered over the globe—including Soviet establishments—have been invited to help.

Laser-tracking probably will be used experimentally as a second method of determining orbit points of the *S-66*. This would mark the first attempt to use this new technique — potentially vastly more accurate than Minitrack, the primary tracking method, and requiring no electrical power from the satellite.

The *S-66* is to be launched by a solid-propellant four-stage *Scout* vehicle from the Pacific Missile Range.

• **Low-cost project**—The National Aeronautics and Space Administration gave *S-66* project management to Goddard Space Flight Center. Goddard in turn gave the design contract to the Applied Physics Laboratory of John Hopkins University.

About one million dollars will be spent for the R&D work, according to Frank T. Martin, *S-66* project manager for Goddard. He told MISSILES AND ROCKETS that this money includes funding for APL as well as money that will be needed for data reduction.

The scientific program has been laid out so that a participant will have to make little or no investment in additional equipment. Most of what is needed is fairly standard. If it is not on hand, it can be bought for about $3200, says Robert E. Bourdeau, *S-66* project scientist and head of Goddard's planetary ionospheres branch.

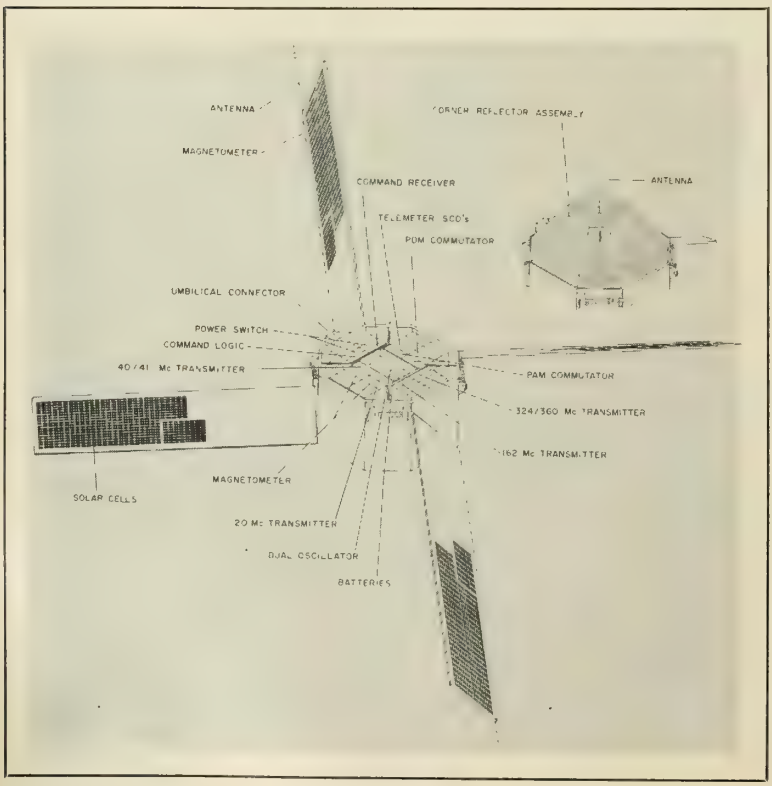
Experimenters specifically contracted by NASA to meet the scientific objectives of the *S-66* project: University of Illinois, Pennsylvania State University, Stanford University, and the Central Radio Propagation Laboratory of the U.S. Bureau of Standards.

• **History**—The *S-66* will rank with Goddard's *Interplanetary Monitoring Probe* (M/R, April 23, p. 32) as one of this country's early scientific monitoring satellites. Both are being designed to gather synoptic data related essentially to one physical phenomenon—the *S-66* to the ionosphere and the *IMP* to solar flares—and to provide these data for an indefinite period.

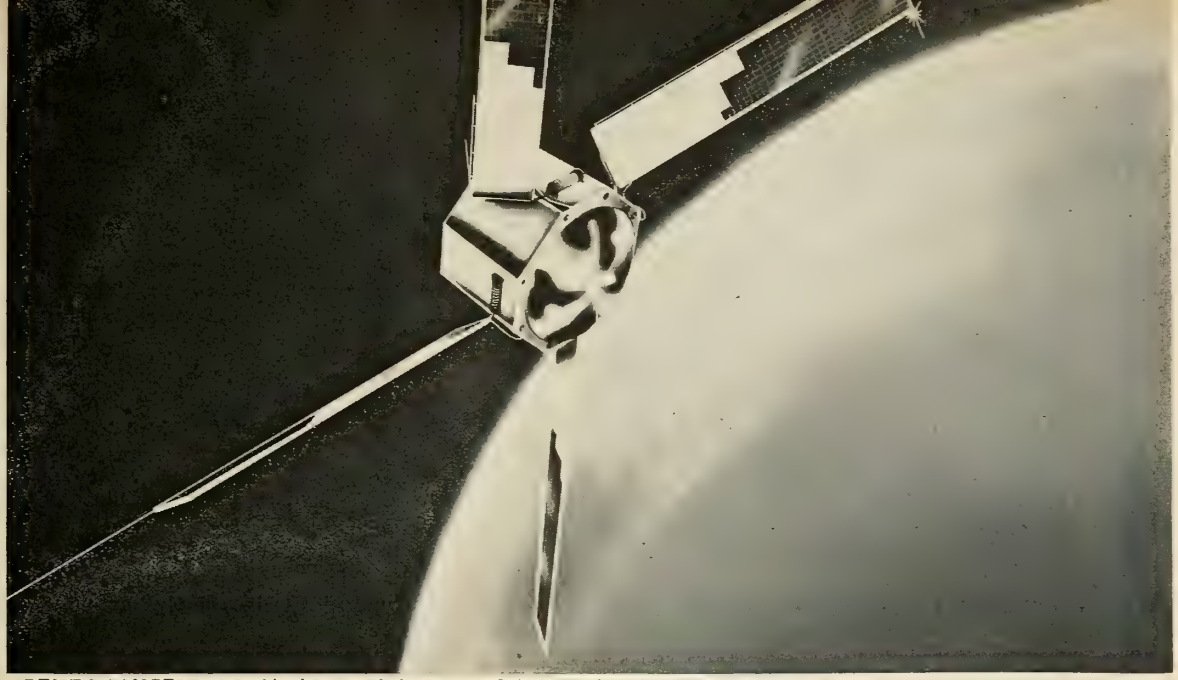
In contrast, Earth-orbiting observatories are designed to gather scientific data about several phenomena on a relatively short-term basis; other scientific orbiters take less than synoptic data.

The U.S. has been monitoring the ionosphere for the past two decades through ionosonde stations which gather data from signals that bounce against the electrified atmospheric layers. The idea of using satellites to get better and more data was shown to be feasible a few years ago by the National Academy of Sciences, and was demonstrated to be practicable by signals transmitted from early satellites.

This work resulted in the Army Ballistic Missile Agency's designing and building two ionospheric beacon satellites known as the *S-45*. Using *Juno II* launch vehicles, the two attempts to put the satellites into orbit failed. About this time ABMA was being changed to the Marshall Space Flight Center and was phasing out of the satellite business.



CUTAWAY OF S-66. Insert at upper right shows reflector assembly.



ARTIST'S CONCEPT of Goddard Space Flight Center's S-66 Ionosphere Beacon Satellite.

The job of probing the ionosphere was given to Goddard, which awarded a contract in October, 1961, to the Applied Physics Laboratory of Johns Hopkins University for design of an improved *S-45* to be known as the *S-66*.

The *S-66* project will complement several NASA programs:

—The *S-27* swept-frequency topside-sounder satellite (Canada). Scheduled to be launched on a *Thor-Agena* this year from the Pacific Missile Range (PMR), the *S-27* will seek data in the polar ionosphere and auroral zones and will measure cosmic noise levels in the 0.5- to 12-Mc frequency range.

—The *S-48* fixed-frequency topside sounder satellite (U.S.). Scheduled to be launched in a *Scout* this year from PMR, the *S-48* will gather the same type of information as the *S-27* but will seek these data in the meridional cross-sections.

—The *S-51/UK-1* international ionospheric satellite launched April 26 in a *Delta* vehicle from the Atlantic Missile Range (AMR). Also known as *Ariel,* the satellite is measuring electron density and temperature and the composion of positive ions in an eccentric orbit inclined about 54° to the equator.

—The *P-21* and *P-21a* electron-density-profile-probes contained in *Scouts* and launched, respectively, on Oct. 19, 1961, and March 28, 1962. These probes were designed to measure electron densities and to investigate propagation of radio waves.

—The *S-30* ionosphere direct measurements satellite also called *Explorer VIII.* Launched by a *Juno II* from AMR on Nov. 3, 1960, this now-silent satellite provided direct measurements of ion and electron concentrations and temperatures in an eccentric orbit inclined 50° to the equator.

• **Scientific goals**—The main reason for building and launching the *S-66* is to study the behavior of the ionosphere over a relatively long period of time. To do this efficiently, investigators set up the following objectives:

—Learn the bulk behavior of the ionosphere as it varies in time and space.

—Relate the ionospheric behavior to the solar radiation responsible for producing ionization.

—Measure the electron distribution in a vertical cross-section between the *S-66* and Earth as a function of latitude, season and diurnal time.

—Determine the geometry and distribution of small-scale irregularities in the ionosphere.

—Study radio-wave propagation through the ionosphere in frequencies ranging from 20 Mc to 360 Mc.

—Evaluate how accurately a laser tracking system determines the path of the *S-66*.

These scientific goals are to be achieved by beacon observing-stations making ground-based measurements of the changes in the character of a radio signal as it passes through the ionosphere. The *S-66* is specifically intended to provide a way to get Faraday rotation and differential Doppler ionospheric measurements in all parts of the globe over a long period of time.

The satellite will be sent on a polar orbit to insure getting wide geographical coverage and to permit studies of the polar ionospheres. The orbit is to be nominally circular to simplify data reduction. To ease certain problems of data analysis, the satellite orbit will be higher than 1000 kilometers—well above the regions producing scintillation and above most of the electrons in the ionosphere.

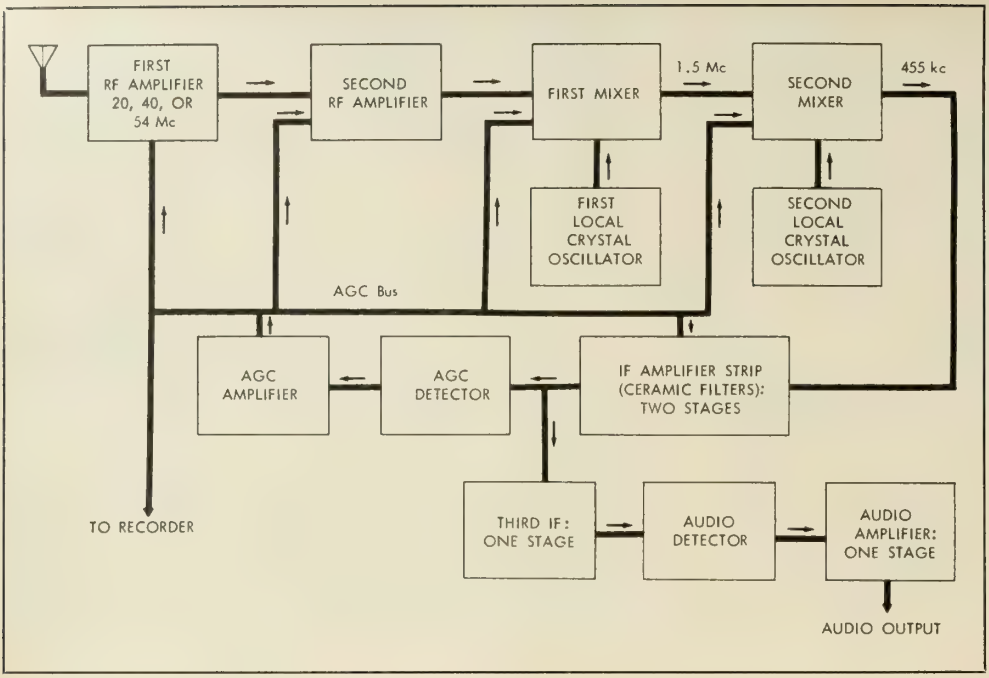
• **Faraday rotation method**—Bourdeau describes as follows the theory behind the Faraday rotation technique of measuring integrated electron density:

"In traversing a magnetoionic medium, a plane wave undergoes a rotation of its plane of polarization, the total angle of rotation depending approximately on the average magnetic field component in the direction of propagation and on the total number of electrons in a column one square meter in cross-section and equal in length to the propagation path.

"As a satellite moves continuously with respect to the magnetic field, there occurs a time-variation of the total angle of rotation that the electric vector experiences along the propagation path. The result is a continuous rotation of the electric vector at the receiving point.

"The magnetic field of the Earth is known to the desired accuracy; therefore, the total angle of rotation along the transmission path determines, approximately, the columnar electron content along the path.

"In practice it generally is not possible to measure the total angle of rotation; instead, the *rate* of rotation and the number of complete rotations between two points on the orbit are determined. Methods have been developed to determine the total electron content from these data."



SUPERHETERODYNE RECEIVER for Faraday rotation observations.

• **The second method**—The Doppler method of measuring integrated electron density relies on the familiar fact that the high velocity of a satellite relative to a ground-based observer results in a large Doppler shift in the observed frequency relative to the radiated frequency. Since in the ionosphere, the phase velocity depends on the electron density as well as on the satellite's speed, the observed frequency will also depend on the electron density. Therefore an analysis of the observed frequency as a function of time can be used to determine the electron content of the ionosphere.

Details for applying the two methods of determining the electron content of the ionosphere are included in a technical bulletin compiled jointly by G. W. Swenson, Jr. of the University of Illinois, and Bourdeau for the participating scientists. Other qualified scientists can also receive the material by writing to Robert E. Bourdeau, *S-66* Project Manager, Space Sciences Div., Code 615, Goddard Space Flight Center, Greenbelt, Md. Ask for: "S-66 Polar Beacon Ionosphere Satellite," Report No. X-615-62-99.

• **Radio transmissions**—The structural and circuit design of the *S-66* is based on the Navy's *Transit V-A* satellite—a yet-to-be-launched member of a set of four navigational satellites expected to form an operational system in October.

The *S-66* ionospheric measurements radio-frequency system will have four coherent unmodulated CW transmitters operating continuously at frequencies of 20, 40, 41, and 360 Mc. These transmissions will be derived from a single ultra-stable quartz-crystal oscillator operating at a frequency of 5 Mc plus 250 ppm (5.00125 Mc).

The three lower-frequency signals will be radiated from dipole antennas mounted on the solar-cell paddles; a dipole mounted on top of the satellite body will be used for 360-Mc transmission. All signals will be linearly polarized.

A crystal-controlled 136-Mc transmitter will be used for telemetry and also to provide a suitable tracking frequency for the Minitrack network stations. In addition, two coherent transmitters operating at 162 Mc and 324 Mc will permit tracking by the existing *Transit* Doppler network.

• **Laser tracking**—The *S-66* will be the first satellite tracked by means of a laser, if current Goddard plans work out. Designed under a contract held by the Missile and Space Div. of General Electric, the laser experiment is expected to give much more accurate orbital data than Minitrack.

Unlike Minitrack, the laser system will not use satellite electrical power: the spacecraft will carry a passive reflector consisting of optical corners to provide an efficient reflecting surface for ground-based pulsed lasers.

The experiment is described as using a laser which emits 1-microsecond pulses with an energy output of about 1-watt-second per pulse, and with a beamwidth of about 10^{-3} radians (two minutes of arc).

The 1-microsecond pulse is expected to provide range data with a resolution of 30 meters (10^{-7} seconds). Angle resolution is expected to be of the order of two seconds of arc — about the same as that obtainable with other optical instrumentation.

Ephemeral predictions from the Minitrack network will be used to program the orientation of the ground equipment for acquisition. Ground-based detectors will include photographic plates and image orthicons used in conjunction with telescopes and cameras on precision tracking mounts.

• **Structure**—The body of the spacecraft will be a right octagonal prism 12 in. high and 18 in. across the flats with four 10-in. by 48-in. solar-cell paddles mounted to the sides of the octagon. Weight of the spacecraft including the laser corner reflector and the hardware for mount and separation is currently estimated at 95 lbs.

• **Attitude control**—The *S-66* will use a yo-yo de-spin system which is expected to reduce the 200-rpm nominal spin rate of the *Scout's* fourth stage and payload down to 10 rpm; within a few weeks the rate is expected to be reduced to less than 0.02 rpm.

Adding to spin damping will be a strong dipole magnet mounted parallel to the spacecraft's symmetry axis. Main purpose of the magnet is to keep the symmetry axis within one or two degrees of the local geomagnetic field vector. A similar magnetic stabilization concept was successfully used in the *Transit* satellites.

Although the *S-66* will have a nominal one-year active life, the experimenters are hoping to get three years of "on" time through judicious use of the satellite's power.

A proposal has been made to form an information center to collect the raw and reduced data from the *S-66*. If it is set up, the facility would surely expedite construction of the map of the Earth's ionosphere. ⌘

Variable-Thrust Liquid Nears Firing

UTC's million-dollar prototype upper-stage will be restartable, burn for 180 seconds

by Robert Lindsey

SUNNYVALE, CALIF. — First firings are planned late this year for a variable-thrust upper-stage liquid engine that will incorporate a variety of advanced concepts developed by United Technology Corp. UTC is spending approximately $1 million to develop and build the prototype.

The engine will be restartable, and capable of thrust variations from 650 to 6500 lbs. It will use a solid gas generator for pressurization, and have an ablative-cooled chamber.

Designed for a burning time of 180 sec., it will use monomethal-hydrazine and mixed oxide fuels. Chamber pressure will be 100 psi. Thickness of the Astrolite liner will be about ½ in. Ejectors will create a vacuum simulating an altitude of 100,000 ft.

Several dozen firings of the engine are scheduled to prove out techniques and design of the injector and chamber, throttle ability and pressurization and re-start, and the composite design of the system.

• **Design considerations** — Engine design calls for expansion cones on the nozzles with a ratio of exit area to throat area of 30 or 40 to one. On flight engines, the expansion cone may be fabricated of the same ablative material as used in the chamber, or radiative-cooled metal could be used.

According to Jack Wilder, manager of UTC's liquid rocket branch, most flight engines would be mounted on a gimbal bearing and would have flexible propellant supply lines to allow movement of the chamber for thrust vector control.

Early UTC studies indicated that one of the primary limitations on pressure-fed engines is pressure loss within the engine—and one of the chief sources of the pressure drop is the tubular chamber of the regenerative cooling system.

This, plus the inherent vulnerability of regenerative systems to damage, both on the ground and through meteorite collision, prompted UTC to study other ways to cool the combustion chamber. Wilder said one alternate — radiation cooled chambers — showed promise, but was discarded for the immediate future because metals to do the job couldn't be expected for sometime.

• **Ablatives questioned** — Use of ablative materials in the thrust chamber was decided upon despite serious skepticism that it was feasible.

Ablative-cooled chambers utilize the same concept as ablative re-entry nosecones: a liner material in the chamber is sacrificed to the combustion heat, absorbing it and boiling away.

A two-year program produced the basic chamber design now used by UTC. It is a composite structure of an ablative liner, a low-density insulating material around the liner and an epoxy-bound filament-wound overwrap.

An injector feeds hypergolic fuels into the chamber.

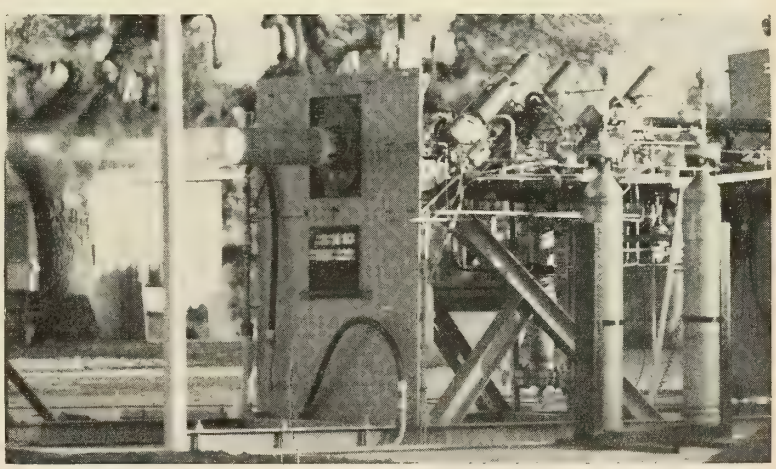
Wilder said the secret of a reliable design is providing exactly the correct depth of ablative liner to all sections of the chamber for the required firing time, and providing enough insulation so that the combustion heat doesn't melt the epoxy. After a firing, the ablative liner looks much like a charred log. Combustion temperatures of more than 5000° F. have been recorded in tests.

• **Injector design important**—Injector design is a critical factor in engine performance, Wilder noted. UTC will reveal little about its injector for proprietary reasons, saying only that it is aluminum and of a duo-doublet-shower head design. Wilder said tailoring the pattern of fuel injection to the geometry of the chamber is critical.

Development of an injector capable of variable thrust has been particularly difficult because of the key requirement to mate the injector precisely to the chamber. The problem of varying the propellant flow and maintaining a stable, efficient combustion process becomes more severe as the ratio of thrust widens.

Wilder said UTC has spent considerable effort studying various ablative materials and techniques for binding the materials, and in learning how thick the walls must be for various combinations of propellant and firing time.

Recent research concentrated on two ablative materials—Astrolite, an epoxy-bound chopped glass cloth, and X-2001, whose composition has not been revealed by developer Avco Corp. ⠿



ABLATIVE-COOLED chamber assembly is fired during UTC's development program.

In-Flight Space Tools Developed

AMF reveals three concepts primarily aimed at problems of on-the-spot engine repairs

by Michael Getler

STAMFORD, CONN.—A line of space tools has been developed here by American Machine & Foundry's Government Products Group—primarily as vessels to test principles of in-flight engine repair.

They will be tested on a mock-up version of Rocketdyne's J-2 booster engine later this month as part of a continuing NASA in-house study of requirements and current capabilities in this area.

Earlier this year, at the Marshall Space Flight Center in Huntsville, Ala., one of these devices (along with other space tools developed by Ling-Temco-Vought, Inc.) was tested on a *Saturn* H-1 engine mock-up.

The AMF tools, according to a company official, are not designed specifically for the J-2, H-1 or any other existing engine but are basically intended to help advance the space-tool state of the art.

Three basic tools for corrective maintenance to piping, fittings, and flange connections make up the AMF line: a spunfit (SPace UNion & FITting wrench, a semi-remote version of the spunfit for use in limited access and visibility areas, and a nut and bolt tool similar in operation to an extension-type socket wrench.

All are operated with two hands and are mechanically designed to provide a closed work force-path to negate torque effects on the spacecraft's attitude during use in a weightless environment. Some of the tools can also be powered by either rechargeable electrical power packs, a pneumatic system, or through a gas drive. The oversized handles for the tools are designed so they can be readily gripped by an astronaut in a space suit pressurized to between 3.5 and 5 psi.

• **Tool types**—The spunfit wrench is actually a pair of tools, both of which connect directly to the work; one is a holding wrench and the other a tool for spinning standard AN fittings on or off. The spinning tool has both semi-automatic and manual ratcheting capability (through a trigger device on the shaft) and both pieces have adjustable handles for various space suit inflation pressures.

The semi-remote spunfit does essentially the same job but allows the operation to be carried on at some distance from the repair area. However, with this tool, the head of the device must first be manually placed on the work. AMF project engineers, at work developing a much smaller head for this tool, point out this technique could be useful in engine repair external to the spacecraft, possibly under a cowling, where work space is limited. Also, they feel the adaption of this method to ground maintenance could prove useful as a means to avoid removing several good engine fittings in order to get at one bad one.

Milton Weiss, AMF program manager for extraterrestrial systems analysis, is confident that the entire effort to develop space tools will eventually lead to improved ground maintenance techniques.

The nut and bolt tool is officially described as a reactionless ratchet drive device for tightening or removal of nuts and bolts on flanges. It is either manually or power-operated, and the socket is designed so that an extremely small turn will hold the tool to the work. The tool has a sliding central shaft to move up or down with the fitting and a horizontal guide bar to maintain the correct hand movement by the astronaut. AMF has also designed a friction-path into all three tools to provide ratcheting action throughout an entire tightening operation.

• **NASA's role** — NASA activity in this area is being carried out by a joint team from the Manned Spacecraft Center at Houston and the Marshall Center.



LEFT: *Spunfit wrench operation is demonstrated by spacesuit-clad AMF engineer. Device consists of holding wrench and spin tool for standard fittings.*

RIGHT: *Semi - remote version of spunfit wrench is aimed at repairs in limited access and visibility areas.*

FAR RIGHT: *Nut and bolt tool has reactionless ratchet drive and mechanical connections to work piece. It also features sliding central shaft and horizontal bar guide.*

The studies generally are aimed at determining the overall space vehicle maintenance problems involved in orbital-launch-type operations, which may eventually involve physically mating vehicles, in-flight refueling, and multiple engine re-starts. Any one of these tasks could require manual assistance from the crew.

The space agency's investigation to date is divided into two areas. One, being handled by Houston, concerns development of a functional outer space suit which will give an astronaut greater freedom of movement without accompanying physical exhaustion. The other is a Marshall effort to define how and to what extent conventional rocket systems and components should be redesigned to permit space maintenance.

"Planning for space maintenance must start concurrently with engine design," Weiss asserts. "The tools and the fittings have to be designed together since there are likely to be many changes required in standard fitting hardware."

As an example, he cites the possibility of moving bolt threads farther back on an otherwise standard fitting as a means of more easily fitting a less sensitive space tool to it.

"At this point," Weiss says, "no one knows exactly what kind of tools are needed. We must try and design a tool which overcomes the fallacy of a conventional tool in a space environment."

In addition to engineering and human factors studies which must be completed before any serious effort can be directed at specific programs, Weiss points out there must also be clear ground rules as to the responsibility for space maintenance. If tools are to be made which will do a particular job, he says, they must be developed either by or in association with the engine prime contractors. The second situation, Weiss feels, may lead to conflicts involving sub-contracted tool designers, with valid concepts, imposing hardware restrictions on the engine designers.

This point, together with current uncertainties concerning future needs, is one of the reasons why AMF thus far has developed tools only to demonstrate techniques. The tools now being demonstrated are somewhat oversized and heavily constructed of steel. Engineers point out that when requirements and capabilities are more clearly drawn, it will be a simple matter to considerably reduce these parameters.

• **AMF's involvement**—AMF has conducted a company-funded program in space tool development since December, 1960, at a cost to date of roughly $60,000. In December, '61, the firm submitted an unsolicited study proposal to NASA, which, while it was not funded, reportedly was "favorably received." Instead, NASA chose to make its own three-phase in-house study which is now in progress.

The first phase of the study involves a continuing analysis of the problems posed by space maintenance, plus a round of tests made in June at Rocketdyne on a J-2 mock-up in which a technician made identical engine repairs dressed in standard work gear and then in an inflated space suit. When in the space suit, the job, using conventional tools, reportedly took eight times as long. As part of phase two, an air-bearing table will be introduced into the situation to further simulate space working conditions. At this point, probably beginning later this month, some of the space tools, including those developed by AMF, are expected to get trial runs.

The third phase is said to call for more authentic environmental simulation, and use of redesigned tools which are now on the drawing boards. These will be further refined according to performance in the upcoming tests.

AMF is also developing a fourth tool in its line of space hardware, a power-driven device for fabrication work. No details are available.

The area of fabrication tools, according to Weiss, is one which will probably offer a better market since it is a newer field with fewer preconceived hardware notions. AMF is developing pyrotechnic forming tools for application in this field. Engineers here feel that fabrication using explosive techniques can be done remotely, with high reliability, and at relatively low cost. ❖





Bipropellants Pushed at Vickers

High-temperature operating control systems actively developed; solids also get attention

by John F. Judge

VICKERS INC. is moving swiftly in development of satellite attitude controls, leading with integrated thrust chambers involving hypergolic bipropellants.

The Division of Sperry Rand settled on bipropellants after an extensive analysis of the various alternates for low thrust systems. The program has led to a successful demonstration of the feasibility of using pulse-modulated reaction controls in the 0.5 to 100-lb. thrust levels.

The Vickers package, described by W. K. Kretschmer, R&D staff engineer of corporate R&D in Detroit, has four major components—combustion chamber, injector, bipropellant valve and a solenoid.

A prototype design, using one solenoid to operate the two poppets of a bipropellant valve through a lever system, has been tested extensively with nitrogen tetroxide and a fuel mixture of 50/50 hydrazine and UDMH.

Pulse-firing systems are the most efficient with bipropellants. There are no problems with non-linear orifices and incomplete combustion. The fast response can be achieved by providing sufficient solenoid power.

As explained by Kretschmer, the system criteria included a minimum of moving parts and fluid passages, plus good injection and combustion chamber design.

This was met by developing the integrated unit. The single solenoid provides better timing—two solenoids pose difficulties here. In addition, a single solenoid cannot shift; either it works both valves or neither. This eliminates the explosion hazard created by prematurely injecting fuel into the combustion chamber.

The power requirements are necessarily below those needed for two solenoids and would thus have advantages in power-limited missions such as early communications satellites, says Kertschmer.

• **Overheating** — With such small packages, Vickers ran into thermal problems. Long runs of 3 to 4 min. produce high heat in the combustion chamber. Since the valves are so close to the chamber, this has the effect of soaking the heat back into the system. Vickers licked this with insulation, and has fired units as long as 18 min. without overheating in the bipropellant valve area.

The chamber posed a major problem. Since the rocket must have extremely high response, regenerative cooling by itself was out because of the time delay in filling the passages. And the smaller the chamber, the more difficult it is to cool regeneratively.

This forced Kretschmer and his associates to cool by absorption of radiation, especially in the throat area. The percentage of ablation on the nozzle cross-section area is larger on small nozzles than in big ones.

Ablative systems were eliminated by the response and constant thrust-level requirements. Vickers uses a combination of absorption and radiation principles, and graphite combustion chambers.

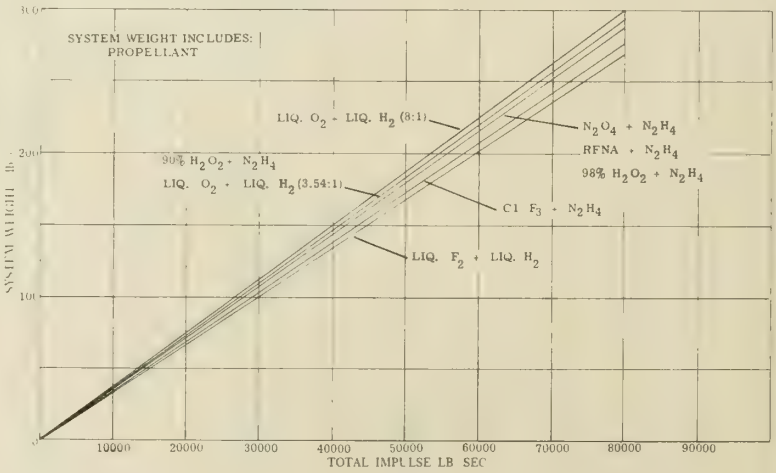
The throat dimensions cannot change during firing. This area must remain constant if control accuracy is to be maintained.

The current combustion chamber assembly consists of the injector, chamber liner and nozzle. Excellent results have been achieved in the tests with graphite liners. The liner is under compression and hoop stress—necessary to hold chamber pressure.

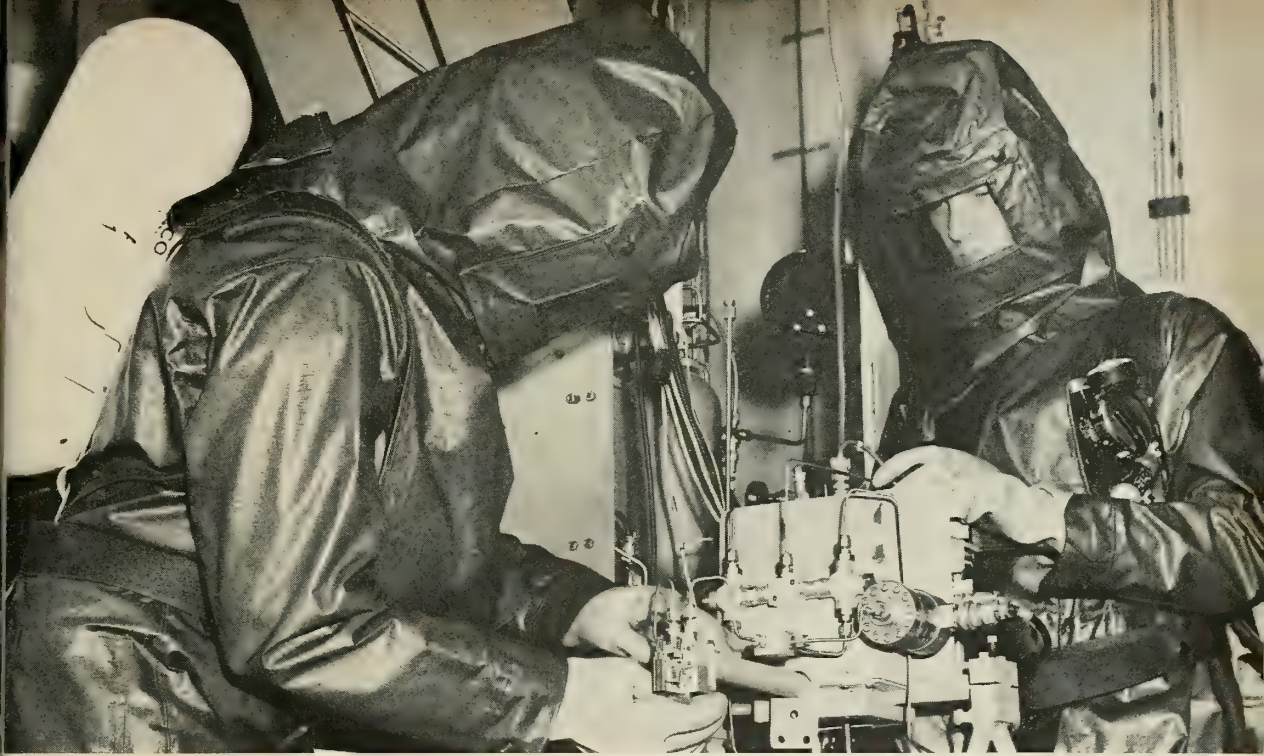
Kretschmer allows the system to "breath" by installing a spring between the chamber and the propellant feed. This takes care of the expansion factors under firing conditions.

The main effort in the design has been directed toward suitable nozzle materials. The no-erosion requirement is a difficult hurdle, especially with high-energy bipropellants. Kretschmer lists the desired material characteristics as high melting point, nonporosity, ductility and a low oxidation rate at temperatures close to 6000°R.

• **Design avoids cracks**—While no presently available materials adequately meet all of these requirements, Vickers test evaluations with refractory metals have shown promise. Early firings resulted in cracked nozzles, thought to be



VICKERS ENGINEERS came up with a weight analysis to compare a number of high-energy bipropellant and cryogenic combinations. In comparing these two graphs, says W. Kretschmer, the significance of considering bulk density and specific impulse is illustrated. Some of the best high-energy propellant combinations compare very favorably



BIPROPELLANT LOADING operations necessitate protective clothing for technicians. The engine is mounted on the far side of the frame together with various recording instruments. Vickers has several small instrumented test stands.

caused by thermal shock. But Kretschmer designed around this failure after discovering other factors, such as poor design and machining stresses, to be far stronger contributors to the cracking than were thermal effects. Some nozzles have jumped from less than 10 sec. useful life to more than 6 min. with no apparent erosion and no cracks.

If the mission calls for higher thrust levels—100 to 1000 lbs.—Kretschmer says proportional bipropellant systems are more applicable. The problem in bringing proportional reaction controls down to extremely low thrust levels lies in the metering orifices. For applications below 30 lbs., the orifices at thrust ratios of 10:1 become so minute that operation is all but impossible because of cleanliness requirements. Pressure also poses a tricky problem.

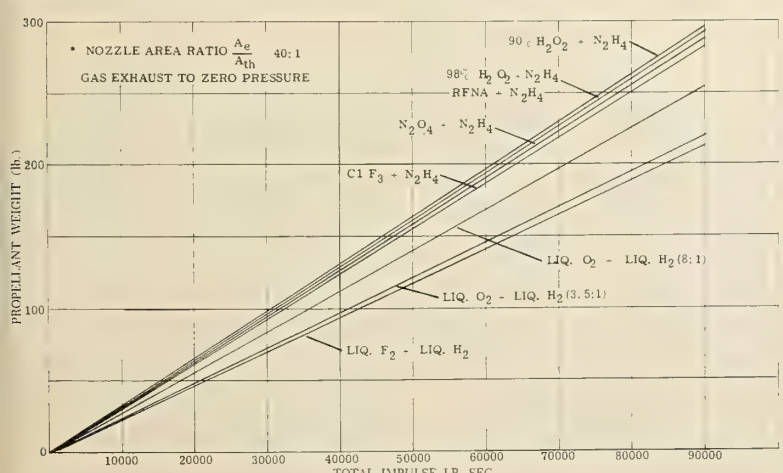
The small rocket at Vickers is part of an extension of the firm's main line of business—flight control mechanisms—and fluid control in space applications depends on reaction and mission time. The firm is not restricting its efforts to liquid units. There are other approaches under investigation.

For example, while bipropellant, pulse-jet reaction controls may be ideal in some cases, a potential market exists in short-time controls. Vickers is deep in hot gas mechanisms utilizing solid propellants for those applications where 2 or 3 min. of control suffices.

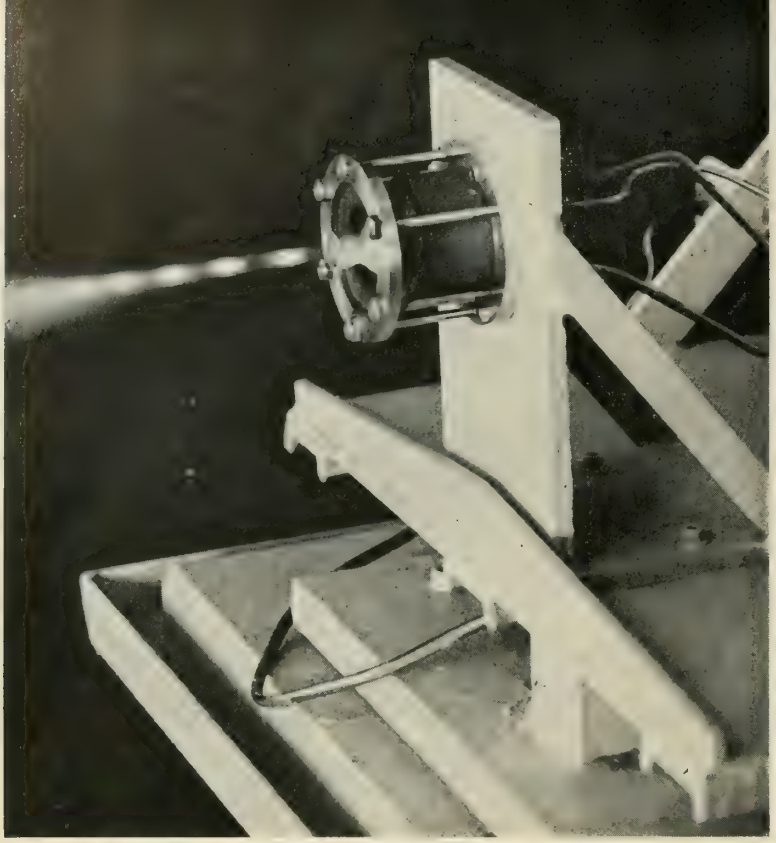
• **Solids are simple**—Solids are extremely simple and can easily adapt to proportional thrust situations. The firm has designs competitive with present peroxide systems, and Vickers experts think solids are the next step down the line.

Reaction control technology leads directly into the liquid (or solid) injection thrust vector control. This is reaction control with the nozzles facing into the system. Vickers has developed valves, has demonstrated system feasibility in this field, and is moving into flight-weight hardware.

In this area of solids, many of the solid propulsion rules do not apply, say Vickers experts. Hard particles in the gas must be avoided, and the trend is to "cooler" propellants. For applications greater than 2 or 3 min., generator weight becomes prohibitive and liquids



with the ultimate cryogenic combination—liquid fluorine-hydrogen. Weight differences among the bipropellants are even smaller, and other factors—such as storability and freezing points—would have to be taken into account in arriving at a final choice.



VICKERS' 25-LB.-THRUST chamber during a recent firing. A multitude of such tests have been made, and company engineers have achieved characteristic velocities of 90-96% theoretical with triplet injection systems.

become more economical. The two do not really compete.

Hot gas servos represent another area of interest to Vickers. These devices overcome the temperature limitations of conventional hydraulic and pneumatic control mechanisms.

• **Gas servos advantageous** — Hot gas servos are advantageous in short-time applications such as controlling aerodynamic surfaces in guided missiles. In addition, Vickers experts point to their compactness and extreme simplicity. This latter quality reduces system complexity in any given application.

Design and method of operation classifies hot gas servo valves into various categories. For instance, Vickers is involved in both open-center and closed-center configurations, but prefers the former.

The open-center design allows large clearances. This increases the unit's capability to tolerate contamination, and also reduces the problems of parts interference caused by thermal expansion.

These servos can be driven by proportional input signals, on-off signals, or pulse-width modulated signals—in general, the same inputs as for hydraulic servo systems.

In a representative system, hot gas is metered through a symmetrical pair of fixed-area upstream orifices into actuator cylinders to a pressure approximately half the supply pressure. The pressures in the cylinders are controlled by a set of differentially variable downstream orifices.

A torque-motor-driven flapper-type control valve varies the downstream orifice areas in response to the electrical input signal.

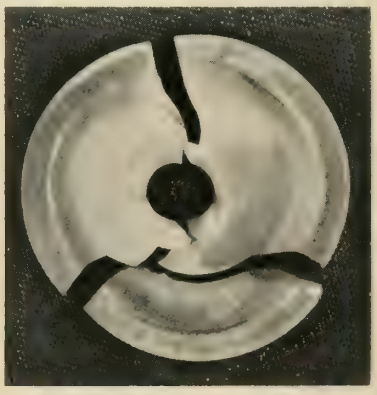
The cylinder pressures act on the opposed pistons, which rotate the actuator output in response to differential cylinder pressures. The output position is sensed by a position transducer whose signal is fed into the feedback amplifier. Any necessary compensation is provided in the feedback amplifier to act on the position signal. The output signal from the feedback amplifier is summed with the input signal to produce the error to drive the motor.

Hot gas mechanisms can use a solid-propellant charge for the gas supply.

Under a NASA contract, Vickers is developing a solid-fueled reaction system for controlling the attitude of space vehicles. Because of the thrust levels in this program, it is possible to use open-center valves, but higher thrust requirements or repeated operations will force a shift to closed-center, pilot-operated valves. ⁂



TWO NOZZLES of modified design using a mixture of tantalum carbide and tungsten carbide. Nozzle at left is unfired; nozzle at right has been fired for 80 seconds.



THIS TANTALUM and titanium carbide nozzle failed after a firing of 30 sec. Vickers solved this through design procedures.

New Markets for Welded Bellows

New England firm now handles more than half the demands of the missile/space industry

WELLESLEY HILLS, MASS.—A series of metal diaphragms and sophisticated welding techniques has been developed to meet the missile/space industry's passion for compactness and reliability and the growing market for welded-diaphragm metal bellows.

The high-performance components are used among other things as volume compensators, pressure sensors, accumulators, valve and rotating shaft seals. Better than half of the U.S. missile/space market is handled by Metal Bellows Corp, the pioneer firm in the field.

Bellows are a familiar item throughout industry—but welded diaphragm bellows are unusual. The conventional bellows is hydraulically formed and used in applications somewhat less demanding than space, defense and nuclear areas.

Welded metal bellows consist of a series of diaphragms, similar to paper-thin washers, alternately welded at the inside and outside edges to form a stack of the desired length. This stack then becomes a flexible pressure vessel capable of expansion and contraction.

This basic characteristic is embodied in every application and because of the welded nature, the bellows can be used in precision instruments and control mechanisms subjected to severe operational stresses.

Welded metal bellows have constant effective areas, long strokes, short nested lengths, large volumetric compensation and excellent spring characteristics.

Withstanding high temperature and pressures with long life, corrosion resistance, reduced outgassing of evacuated and sealed assemblies and leak tightness are also natural attributes of the elements.

The firm currently markets welded metal diaphragm bellows in sizes ranging from 0.25 in. to 12.5 in. diameter but development efforts are under way to spread the range in both directions.

• **Bellows expansion** — In other areas, R. Shamie, president of MBC, says the firm is pushing higher temperature materials—the present ceiling is about 1500°F. There is work in progress aimed at utilizing bellows as pressure sources, exactly opposite their classic function as sensors. The firm is developing a series of bellows actuators, but Shamie did not elaborate.

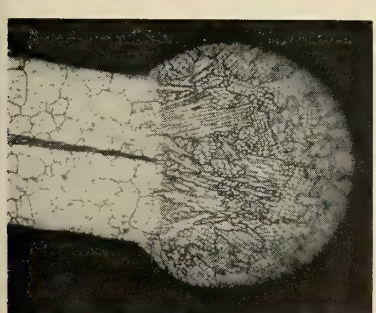
In a unique approach to its market, Metal Bellows Corp. will give a customer enough data for him to complete over 90% of the final bellows design needed. The customer can pick the envelope most suitable to his particular application and calculate the length, thickness, nested length and other details necessary for optimum functioning.

MBC works with customers through this phase and then manufactures the bellows. A vast amount of engineering data on a number of specific bellows applications has been generated and is available.

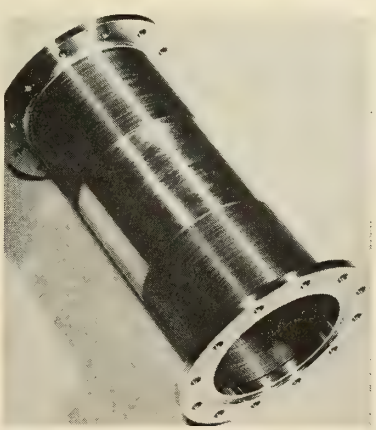
This method—starting from scratch toward a known end function—results in a completely finished and engineered component for a specific purpose.

The firm is adapting an electron beam welding machine to its custom production line. The unit has reduced certain surface finishing operations and enhances reliability in other instances. When a bellows is designed to sense pressure changes indicative of altitude, the component must be evacuated. By adopting electron beam welding, MBC performs the evacuation as a matter of course and achieves better seals than with the former soldering process.

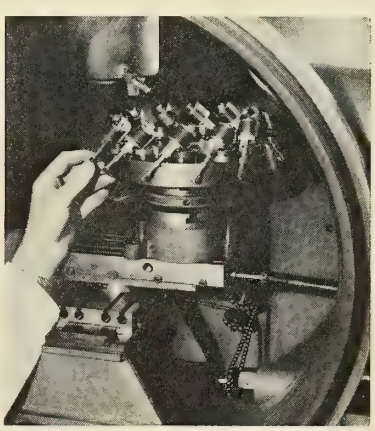
Welded metal bellows are in most missiles and space projects. Seal assemblies in the *Titan*, attitude control seals in the *Agena* vehicle and the velocity meters in the *Minuteman* are but a few of these applications. ⌘



PHOTOMICROGRAPH shows uniformity of minute welds achieved as matter of course at Metal Bellows Corp. Techniques are proprietary with the firm.



LIQUID OXYGEN fumes escaping from X-15's tanks while mated to B-52 are transmitted to mother ship through this 4-in. welded bellows.



ELECTRON BEAM welding techniques are under investigation at MBC as a means of upgrading reliability of the bellows while cutting production costs.

missiles and rockets



special report ...space electronics

ON SEPTEMBER 17, MISSILES AND ROCKETS, the Weekly of Space Systems Engineering, will publish a comprehensive report on space electronics . . .

- Market forecast through 1970
- Government procurement, who and where
- Technical coverage
  - . . . guidance, control, and navigation
  - . . . telemetry
  - . . . communications systems
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  - . . . checkout systems
  - . . . APU's
  - . . . electronics requirements for lunar base support systems
  - . . . environmental testing problems

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space reservations by august 27
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ENTAC Swells Nord's Antitank Output

French firm is also busily producing missiles in SS series; air-to-surface work continues

by Anthony Vandyk

BOURGES, FRANCE—Production of the *ENTAC* missile is building up steeply at a modest but modern plant here which is responsible for the production of Europe's best-selling missiles —the Nord Aviation family of antitank weapons.

Developed from the *SS-10* by the French government DEFA agency, the *ENTAC* has been in production at Bourges for about six months. Output, currently running about 600 *ENTACs* a month, will increase to about 3000 within the next year. The U. S., Belgium, Switzerland and France have ordered the *ENTAC*. Present contacts call for the production of 60,000

Production at Bourges at present mainly involves the *SS-11* and *ENTAC* antitank missiles. Production of the *SS-10* is virtually completed. About 30,000 have been built by Nord at Bourges and at the development plant at Chatillon near Paris. The *SS-10*, the first of the Nord wire-guided missiles, entered production in 1955. (It was, incidentally, used in combat in 1956 by the Israelis against the Egyptians).

The *SS-11*, an advanced and heavier version of the *SS-10* with a range of about 12,000 ft. (compared with the *ENTAC's* 6600-ft. range) is in full production at Bourges. About 32,000 have been built to date.

While the latest in the *SS* series, the *SS-12*, has entered limited production at Chatillon (it will only be moved to Bourges if big additional orders come in), the *SS-11* is still being developed by Nord. The latest version—the *SS-11B1*—is transistorized. Another version employs a gyrostabilized sighting system (built by Cotelec) and is intended for naval use.

Also under development by Nord is a version of the *SS-11* using automatic guidance—the operator trains his binoculars on the target and the missile follows his line of sight. This may well be the missile Nord entered in the U. S. *TOW* contest. Production of this missile may be carried out in cooperation with a German manufacturer (probably Boelkow). Still another Nord development project is a simple and cheap surface-air missile for use only in clear weather.

• **Air-to-surface** — While the bulk of Nord's missile activities to date have involved ground-launched weapons, the company is also active in the air-surface field with the *AS-20* and *AS-30*.

The *AS-20* went into production last year and is used on the Fiat G-91 NATO lightweight fighter. Production of the *AS-30* is scheduled to start in September. An important *AS-30* order to equip some Canberra bombers of the Royal Air Force is expected to be firmed up very shortly.

Nord is also hopeful of selling *AS-30s* to some of the European air forces being equipped with the F-104G. The *AS-20* and *AS-30* are at present equipped with visual guidance systems. Therefore, their operation is restricted to clear weather. However, Nord is developing versions of these missiles with automatic guidance.

Nord continues to be active in the target drone field. The *CT-20* is still in limited production and a reconnaissance version, the *R-20*, is under test. The supersonic *CT-41*, which encountered some difficulties during its initial development phase, is still under test. Much of the work on the drones is carried out at the Nord plant at Le Mureaux, which also builds part of the European-manufactured Raytheon *Hawks* and works on ballistic missile studies for the SEREB company.

The activities at Le Mureaux and at the Nord development plant at Chatillon complement the work at Bourges. Four miles from the Bourges plant is the Subdray test center which is to be used for testing large solid-propellent rocket motor assemblies. Also near Bourges is the firing range where Nord tests antitank missiles. Nord's policy is to fire nine out of each 1000 missiles built. If one fails, another 14 are fired. If another fails then a further 21 are fired.

Under the energetic guidance of its President, Jean Cahen-Salvador, Nord Aviation is deeper in the missile business than any other major European aerospace manufacturer. As of June 1 the company had produced 76,100 missiles (including 800 target drones) and the 100,000 mark should be topped by the end of next year. Apart from France, 15 nations have ordered Nord missiles. Last year 48% of Nord's $80 million sales involved exports—and most of the exports involved missiles. ⌗



Mock-up of French Nuclear Missile?

FIRST RELEASED photograph of the French Mach 2 bomber Mirage IV-03 (prototype 03 corresponding to the definition of the production aircraft) shows it carrying what is believed to be a mock-up of the 185-mi.-range nuclear-tipped missile mentioned recently by the Chief of Staff of the French Air Force, Gen. P. Stehlin.

New AFSC Division

(Continued from page 13)

a one-of-a-kind piece of equipment.

Labs will remain in their present locations, Demler emphasized. Citing the Directorate of Materials & Processes at Wright-Patterson AFB, Ohio, as an example, he pointed out that this is a good model for the rest of the labs. Within the overall complex, there are some five different subordinate labs, representing the AF's expertise in the materials area. The same organizational scheme might be applied to Rome AFB, N.Y. where there are some 12 individual labs. Under the new plan, these might be consolidated under a single, overall lab chief, and with this strengthened capability becomes the AF's center for electromagnetics.

The next year, Gen. Demler noted, will largely be spent working out with the existing labs the details of the consolidated lab changes.

The Centers and activities falling under the coordination and control of the Research and Technology Division include:

—Rome Air Development Center: electromagnetic energy conversion, signal detection and processing, computation and display, command and control system applications, test and evaluation and associated areas.

—Directorate of Research, AFSWC: Nuclear weapons applications, effects, ballistics, delivery techniques and safety.

—6593rd Test Group (Development): Rocket propulsion components, systems, propellants and associated ground equipment.

—Directorate of Materials & Processes, ASD: Materials sciences, metals and ceramics, non-metallic materials, manufacturing technology and materials applications.

—Directorate of Avionics, ASD: Electronic techniques, optics and photo materials, navigation and guidance, vehicle defense, electromagnetic warfare and communications and reconnaissance as applied to aerospace-borne systems.

—Directorate of Aeromechanics, ASD: Flight vehicle dynamics, performance, control, launching, alighting, structures, crew station, environmental control and escape, aerodynamic decelerators, air breathing, electric and advanced propulsion, fuels and lubricants, flight vehicle power, site support and related areas.

—Directorate of Targets & Armament: Non-nuclear weapon warheads, components, effects, ballistics, delivery techniques, safety and associated ground equipment. ⌘

Four important questions you should ask before selecting any scientific or engineering computer.

They lead to the one sure way to find the computer that suits you best.

A computer investment can be a wise one or an expensive one. Basically it depends on finding the computer that best serves your needs. The Recomp® line of solid-state scientific and engineering computers has been found ideal for many leading companies. Perhaps it could best meet your needs. The following questions may offer some guidance in your choice.

(1) What should you pay for a computer?

Scientific problem-solving computers sell from $40,000 and up. They lease from $1,100 and up a month. But even more important than initial cost is how much a computer will save you over a period of time.

A feasibility study showed that a Recomp computer could save almost $70,000 more than its nearest competitor in a year on a given project. In addition, Recomp offers an ideal lease price range. For medium-scale needs, Recomp II starts at $2,495, and with a complete line of peripheral equipment goes to $4,500. Recomp III is ideal for small-scale needs. You can lease one for $1,495, complete.

(2) What software is available?

Outstanding software—compatible compilers, interpretive routines, programming library and exchange, special applications, users groups, etc.—will help you get the maximum use of your computer. Recomp's software and accessory line are the most up-to-date in the computer industry. And an extensive programming library is available without charge.

(3) Will you have to hire specialized computer personnel?

Some computers demand specialized programming personnel to operate them. Others are so simple that engineers can program their problems directly. This ease of programming saves time and increases computer use. One of the easiest computers to program and operate is Recomp. Engineers with less than eight hours instruction are able to use the computer profitably.

(4) What will a computer do for you?

You'll probably never know the **complete** answer to this until you have one in your own firm. Most companies find myriads of uses in addition to the one they originally bought the computer for. But some computers are more helpful than others. For example, a company that once got 2 proposals a year from a top creative scientist, was able to increase this figure to 3½ with a computer (not Recomp). But with Recomp this company is now able to get **nine** proposals each year.

The one sure way to select a computer

The computer requirements of every company are unique. The best way to find the computer that fits your own specialized requirements is through a computer feasibility study. This is the only way to know **exactly** what computer suits you and your company best.

One final tip: no computer feasibility study is complete without Recomp. Put Recomp side by side with **any** comparable computer on the market. Let the facts speak for themselves. Write today for this helpful guide: "How To Conduct A Computer Feasibility Study."

Recomp

Recomp is a product of Autonetics Industrial Products
Autonetics is a Division of North American Aviation

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Name _____

Position _____

Company _____

Address _____

City _____ Zone ____ State _____

Joint DOD, NASA effort . . .

Refined PERT System Guide Issued

Manual should help government contractors predict costs of complex development projects

by Lawrence J. Curran

THE DEPARTMENT of Defense and NASA have jointly produced a manual that adds a new dimension—cost—to the widely successful PERT (Program Evaluation and Review Technique) management system for handling complex development projects.

The manual, "DOD and NASA Guide, PERT COST System Design," is now available to government contractors through the Superintendent of Documents, Government Printing Office, Washington 25, D. C.

PERT was introduced by the Navy in 1958 to aid managers in planning and controlling the three variables of large weapon system development programs —time, cost and technical performance. It was eminently successful in bringing the *Polaris* program to fruition sooner than expected, but its early application has been limited to evaluation of time schedules.

The DOD-NASA document is intended to serve as a guide for government contractors, and is the result of modifications to the initial system design. The third variable—technical performance—presumably will be inserted into the formula when the Air Force completes its work on a further refinement of the system to be called PERT V.

PERT/COST is the application of costs to the system, which enables both contractor and program manager to forecast possible over-runs or under-runs of time and cost in sufficient time to take preventive action.

Defense Secretary McNamara has endorsed use of the manual throughout DOD, and NASA Associate Administrator Robert C. Seamans, Jr., has said his office will soon establish a number of controlled experiments for application of the system on a number of selected projects.

• **Will prevent overlapping**—Both men see the basic guide as a welcome solution to the overlapping of similar but independent management procedures that had been developing within the military services, NASA and among several major defense contractors.

Modifications to the initial PERT system design were proposed after a review of the system conducted by the Office of the Secretary of Defense with: 1) the assistant secretaries of the military departments for logistics, financial management, and research and development; 2) the Logistics Management Institute; 3) NASA; 4) DOD's PERT coordinating group; and 5) selected contractors with knowledge of PERT/COST.

A summary of the PERT/COST system's refinement of the initial PERT time system shows this flow:

Both cost and schedule are planned and controlled on a common framework. This integration not only permits more accurate measurement of progress but also enables managers to appraise more realistically the consequences of alternative courses of action.

After the schedule has been prepared, the responsible operating and management personnel develop cost estimates for each "work package" (unit of work required to complete a specific job, such as a report, design, drawing, a piece of hardware, a service, etc.). Costs are based on manpower and other resources required to perform the project on schedule. Managers then analyze the estimates to eliminate unnecessary manpower costs and premium payments for materials and services.

For example, monthly manpower requirements are totaled by skills and examined to minimize unnecessary overtime and unnecessary hiring caused by manpower peaks followed by layoffs. This manpower "smoothing" is done by rescheduling slack activities to periods when the skills are not required by critical activities. Rescheduling can also eliminate or reduce premium payments for materials and services.

• **Actual vs. predicted costs**—The PERT/COST technique requires periodic comparisons of the actual costs incurred for each work package, and the actual time consumed by each activity, with their original estimates. This comparison significantly improves cost and schedule control by establishing the cost and time status of the project, and by identifying any potential cost over-runs and schedule slippages.

Concurrent estimates of the cost and time needed to complete work not yet performed are also obtained in order to predict future schedule slippages and cost over-runs, and to identify difficulties in the performance of critical work packages early enough to take constructive management action.

The PERT/COST system is designed to operate on a decentralized basis. Where possible, the contractors or government activities performing development or construction projects should handle the bulk of any necessary data processing, and take appropriate management action on their own initiative.

• **Manual's contents**—The 145-page document is divided into an introduction, five chapters and two appendices. Chapter I considers PERT/COST management reports. Essentially, these reports provide management with the following information in varying degrees of detail:

—The current project plan, schedule and budget.

—Time and cost performance to date in relation to the plan.

—Time and cost projections for completion of the project objectives.

The reports also call attention to potential trouble spots, making it possible for managers to anticipate budget variations.

The remaining "meatier" chapters —II and III—detail PERT/COST's system description and operating procedures. Chapter IV considers PERT/COST supplements entitled "The Time-Cost Option Supplement," and "The Resource Allocation Supplement," respectively.

Chapter V, "Computer Master Files," touches on computer programs for the IBM 7090 being developed by the U. S. Naval Weapons Laboratory, Dahlgren, Va., and by the Air Force Systems Command. These programs will be available later to assist contractors who plan to program their own data processing gear for PERT/COST. ⠿

The Industry Week

Firth Sterling Expands

Firth Sterling Inc. recently completed a million-dollar equipment improvement program at its Steel Division facility in McKeesport, Pa. The program represents a 40% increase in equipment investment and includes two additional Hopkins Process consumable electrode melting machines, a continuous atmosphere-controlled annealing furnace, a vacuum induction furnace and a 20-in. cogging mill. A significant percentage of the firm's business is in the form of silver-infiltrated tungsten nozzles for a major missile weapons system. Firth Sterling accounts for about 35% of all the tungsten powder manufactured in the U.S. in the nozzle program and in a high-velocity antitank warhead. Powder metallurgy methods are used in the nozzle production. The silver is infiltrated thermally into porous tungsten bodies. The firm can handle nozzles up to 27 in. in diameter.

News of Mergers and Acquisitions

Walter Kidde & Co., Inc., purchased Douglas Randall, Inc., Westerly, R.I., electronic components manufacturer. Randall will be operated as a wholly-owned subsidiary of Kidde. . . . *Allied Research Associates, Inc., Boston, acquired Radiation Counter Laboratories, Inc., Skokie, Ill. RCL is active in the nuclear instrumentation field.* . . . Kaman Aircraft Corp. purchased Power Transmission Systems, North Caldwell, N.J. . . . *Gulf Coast Engineering & Research Corp. purchased Texowell Service & Machine Co., a machine tool firm active in the missile and space field.* . . . Associated Spring Corp., Bristol, Conn., acquired Westmetal Products Co., Los Angeles, producer of custom metal stampings, drawn metals, and fabricated metal assemblies. Westmetal will operate as the Westmetal Products Div. of ASC. . . . *Electro-Mechanical Research, Inc., Sarasota, Fla., acquired Solartron, Inc., Anaheim, Calif., formerly the U.S. subsidiary of Solartron, Ltd., of England. The company manufactures transfer function analyzers used extensively in checkout of servo systems, with wide application in missile flight-control system and guidance system prelaunch checkout.* . . .

Corporate Division Changes

Texas Instruments Inc. established a Materials & Controls division "to capitalize on long-range opportunities in the materials and electrical controls fields." The new division consolidates three company activities: Metals & Controls Inc., Materials & Sensors Dept., and the Materials Research & Development Lab. . . . *Vitro Corp. of America set up Vitro Services as an independent division to expand technical operation and maintenance programs for both government and commercial customers. The division will operate as part of the Electronics, Systems and Development Group and will be headquartered at Fort Walton Beach, Fla. Vitro also established a public relations office in Washington, D.C.* . . . The Bendix Corp. organized a single program to plan and conduct all company engineering and development for space navigation and for guidance, stabilization and control of satellites and other space vehicles. The program will combine R&D capabilities of seven Bendix divisions and "will analyze the nation's future space missions and define the navigation subsystem requirements for such missions as Earth-orbiting space labs, lunar surface exploration vehicles and both manned and unmanned flights to Mars and Venus." . . . *Aerospace Corp. is forming a new Communication Satellite Systems Program Office in response to increased emphasis on military communication satellites. Wilbur L. Pritchard, formerly of Raytheon Co. has been named director. Corporate president Dr. Ivan A. Getting said the Offices "are being established to provide effective and sufficient technical management support—primarily general systems engineering—of the recently expanded Air Force mission in the military communication satellite area."* . . . Air Force Systems Command activated a permanent Research and Technology Division headquartered at Bolling AFB, Washington, D.C., to provide centralized planning and direction of applied research and advanced technology programs under its jurisdiction.

International News Briefs

Aerojet Delft opened a new plant in Plainview, Long Island. The company was recently formed by Aerojet-General Corp., and N. V. Optische Industrie de Oude Delft of Holland for development of advanced electro-optical products. . . . *West Instrument Ltd., a British subsidiary of Gulton Industries, Inc., moved to new, enlarged facilities at Brighton (Sussex), England.* . . . Philips N. V., Eindhoven, The Netherlands, stockholders subscribed for $202,000,000 worth of stock in a new common share offering in one of the largest equity financings in recent years. Proceeds will be used for capital requirements and improvement, replacement and expansion of plant and other facilities.

New Industry Facilities

North American Aviation, Inc. will expand its Rocketdyne Div. facilities at Canoga Park, Calif., to handle production of main components of F-1 and J-2 engines for *Advanced Saturn.* New buildings, with 274,000 sq. ft. of floor area, will be constructed by Warner Ranch Co., Inc., and leased to Rocketdyne. Construction will start immediately after final zoning action. . . . *Douglas Aircraft Co.'s Missile and Space Systems Div. will develop a space science center on a newly acquired 245-acre site on Huntington Beach, Calif. Work is scheduled to begin on the first installations in the next few months, with complete development of the site projected over a 10-year period. Cost of the first structures will be some $8 million, with completion scheduled for the end of 1964. It will include a giant vacuum space chamber, labs and other facilities required for expanding activities of the division.*

AWARDS

AIR FORCE

$23,000,000—**North American Aviation, Inc.,** Los Angeles, for production of *Minuteman* guidance and control systems.

$10,699,079—**Air Products and Chemicals, Inc.,** Allentown, Pa., for operation of government-owned nitrogen plants at Denver, Colo., and Nimbus and Santa Susana, Calif.

$7,500,000—**Martin Marietta Corp.,** Baltimore, for continued research and development work on the *Titan II* ICBM.

$5,800,000—**Aerospace Corp.,** El Segundo, Calif., for systems engineering and technical direction of ballistic missile and space programs.

$5,634,240—**Lockheed Aircraft Corp.,** Sunnyvale, Calif., for continued work on space programs.

$3,353,000—**Boeing Co.,** Seattle, for work at the Whiteman Air Force Base, Mo., *Minuteman* missile site (supplemental contract).

$3,200,000—**General Motors Corp.,** Detroit, for continued research and development work on the *Titan II* missile guidance program at Milwaukee.

$2,300,000—**North American Aviation, Inc.,** Los Angeles, for development of guidance and control systems for the *Minuteman* missile (supplemental contract).

$2,000,000—**Lockheed Aircraft Corp.,** Burbank, Calif., for continued work on the *Agena* space vehicle.

$2,000,000—**Sylvania Electronic Products, Inc.,** for ground electronic systems development for the *Minuteman* missile at Waltham, Mass., and Buffalo, N. Y.

$2,000,000 — **General Telephone & Electronics Corp.,** New York, for development of an improved ground electronics system to provide command and control functions for *Minuteman*.

$1,800,000—**Lockheed Aircraft Corp.,** Burbank, Calif., for work on a space program at Sunnyvale.

$1,730,000—**Douglas Aircraft Co., Inc.,** Santa Monica, Calif., for launch services at Santa Monica and Vandenberg AFB (supplemental contract).

$752,500—**Avco Corp.'s Everett Research Laboratory,** Everett, Mass., for a ballistic missile reentry research program (supplemental contract).

$99,289—**Martin Co.'s Institute for Advanced Studies,** Baltimore, for basic research in nonlinear mathematics relating to problems in space flight, long-range communications and automation.

$56,000—**Dynatech Corp.,** Cambridge, Mass., for experimental and analytical work in conversion of liquid oxygen to oxygen vapor.

General Dynamics/Astronautics, San Diego, Calif., for design, development and construction of a prototype lunar transponder (undisclosed amount).

Ford Motor Co., Aeronutronic Div., Newport Beach, Calif., for a study of the role of man in the U. S. aerospace force of the future (undisclosed amount).

ARMY

$682,232—**Avco Corp.'s Everett Research Laboratory,** Everett, Mass., for re-entry monitoring activities to include study of wake measurements as a means of discriminating between missiles and decoys for the *Nike-Zeus* system.

$25,000—**Bulova Research & Development Laboratories,** Woodside, N. Y., for design of an improved nose component for the warhead fuze system of the *Shillelagh* tactical missile.

NAVY

$3,637,890—**Bermite Powder Co.,** Saugas, Calif., for jet-assisted take-off rocket motors.

$2,657,059—**Vitro Corp.,** Silver Spring, Md., for weapons system engineering services on the *Terrier, Tartar* and *Talos* missile systems (3 contracts).

$1,500,000—**Thiokol Chemical Corp., Reaction Motors Div.,** Bristol, Pa., for production of liquid-propellant rocket engines for *Bullpup* missiles.

$1,200,000—**Land-Air, Inc.,** Chicago, for data programing and reduction services for all missile instrumentation at the Navy's Pacific Missile Range, Point Mugu, Calif.

Republic Aviation Corp., Farmingdale, N. Y., for development of a nuclear-energy-operated gyroscope (undisclosed amount).

Hercules Powder Co., Wilmington, Del., for second-stage solid-propellant motors to power the *A-3* (long-range) *Polaris* (undisclosed amount).

NASA

$10,544,983—**General Dynamics Corp.,** San Diego, Calif., for design and development of high-impulse upper-stage vehicles.

$8,373,311—**U. S. Army Corps of Engineers,** Mobile district, Alabama, for facility design, engineering services, construction modification and instrumentation, and support services for *Saturn* static test facilities.

$7,186,350—**Boeing Co.,** Seattle, for preparatory efforts leading to engineering, fabrication, assembly, checkout, static testing, transportation and launch of the *Saturn* S-IC stages.

$3,950,000—**Chrysler Corp.,** New Orleans, for *Saturn S-I* stage work preparatory to production.

$1,500,000—**General Dynamics Corp.,** San Diego, for fabrication and delivery of *Centaur* vehicles.

$1,497,000—**General Dynamics Corp.,** San Diego, for engineering services and necessary materials to modify vehicles for spacecraft.

$1,403,824—**Instruments for Industry, Inc.,** Hicksville, N. Y., for sophisticated piece of electronic countermeasures equipment.

$729,834—**Lockheed Aircraft Corp.,** Sunnyvale, Calif., for study of early manned interplanetary missions.

$450,000—**IBM, Federal Systems Div.,** Rockville, Md., for computer support services for Projects *Mercury, Gemini* and *Apollo*.

$197,207—**Lockheed Aircraft Corp.,** Sunnyvale, Calif., for study of application of solid-propellant motors to future *Saturn* C-1 class vehicles.

$150,000—**Republic Aviation Corp.,** Farmingdale, L. I., N. Y., for fabrication of various *Saturn* space vehicle components.

$141,594—**North American Aviation, Inc.,** Downey, Calif., for conceptual design study of reusable ground launch vehicle in the 50-to-100-ton orbital payload class.

$99,110—**Allis Chalmers Manufacturing Co.,** Milwaukee, for research and development of an open-cycle fuel cell system for space vehicles.

$95,000—**Esterline Angus Instrument Co., Inc.,** Indianapolis, for development of flight-test program to demonstrate concept of a rocket thrust-vector-control system.

$92,000—**North American Aviation, Inc.,** Downey, Calif., for study of conceptual design of reusable 10-ton orbital carrier vehicles.

$65,392—**Cosmic Corp.,** El Cajon, Calif., for *Saturn* assembly components.

$60,710—**Republic Aviation Corp.,** Farmingdale, L. I., N. Y., for vibration tests on heavy space vehicle components.

$52,755—**Grumman Aircraft Engineering Corp.,** Bethpage, L. I., N. Y., for study of astrodynamics of lunar satellites.

$49,843—**General Electric Co.,** Syracuse, N. Y., for design and development of a solid-state converter for space vehicles.

$38,233—**Matthews Research Inc.,** Alexandria, Va., for systems for functional testing of precision space vehicle components.

$32,030—**Fred D. Wright Co., Inc.,** Nashville, Tenn., for *Saturn* C-1 structural parts.

ITT Industrial Laboratories Div., Fort Wayne, Ind., for development of special photoelectric cameras for research in space (undisclosed amount).

Martin Co., Baltimore, for preparation of a lunar handbook and Earth-orbital operational manual (undisclosed amount).

REQUESTS FOR BIDS

GENERAL PROCUREMENT
ARMY, NAVY, AIR FORCE & NASA

U.S. Army Signal Supply Agency
Fort Monmouth Procurement Office
Fort Monmouth, N.J.

Calls for completion and verification of the evaluation techniques originally established in the development effort initiated under contract DA 36-039, SC-85047 for a long-life reliable planar triode, Type 2-5457, intended for a communication satellite application. A contract is in the process of being awarded to General Electric Co., Owensboro, Ky., therefore bid sets are not available and no other offers will be considered—RFP-SC-36-039-63-11024-94.

Aerospace Procurement Div.
Subsystems Procurement Branch
Norton AFB, Calif.

Depot-level maintenance of the following guided missile components in support of the SM-68 (Titan II) missile system: MBAE 1420-857-0795 AE, gyro, 26 ea., to consist of IRAN, TCTO, TOC and/or modification as necessary to return item to fully serviceable condition. Delivery required 45 days after receipt of item by contractor. Items being procured on this RFP were developed and produced by Minneapolis-Honeywell Regulator Co., 2747 4th Ave., Minneapolis 8, Minn., as a subcontractor for Martin-Marietta Corp., Denver 1, Colo. Drawings, engineering data, specs and copies of RFP not available through AF channels for distribution. Negotiations for services being conducted with Minneapolis-Honeywell Regulator Co., Minneapolis, Minn. Any inquiries relating to subcontracting opportunities should be made directly to the above contractor. RFP. 04-607-63-92.

NASA Manned Spacecraft Center
Apollo Procurement Office
Houston, Tex.

Research and development of the lunar excursion module of the Apollo spacecraft—RFPMSC-63-181P—Bid opening 9-4-62. The following firms have been invited to participate: Lockheed Aircraft Corp., 2555 N. Hollywood Way, Burbank, Calif.; The Boeing Co., Box 3707, Seattle

24, Wash.; Northrop Corp., P. O. Box 1525, 9744 Wilshire Blvd., Beverly Hills, Calif.; Ling-Temco-Vought, P. O. Box 5003, Dallas 22, Tex.; Grumman Aircraft Engineering Corp., Bethpage, L. I., N. Y.; Douglas Aircraft Co., Inc., 3000 Ocean Park Blvd., Santa Monica, Calif.; General Dynamics Corp., 1 Rockefeller Plaza, New York, N. Y.; Republic Aviation Corp., Conklin St., Farmingdale, L. I., N. Y.; Martin-Marietta Co., Friendship Airport, Baltimore, Md.; North American Aviation, Inc., International Airport, Los Angeles 9, Calif.; McDonnell Aircraft Corp., Lambert-St. Louis Municipal Airport, Box 516, St. Lois, Mo. It is suggested that small business firms or others interested in subcontracting opportunities on this procurement make direct contact with the above firms. For information purposes, NASA has available a limited number of copies of the technical approach section of the Lunar Excursion Module Section of the Lunar Excursion Module Statement of work for distribution to potential subcontractors. This document is classified and should be requested from the Manned Spacecraft Center, Apollo Procurement Office. When the supply has become exhausted, a copy will be available for reading at the following offices: Western Operations Office, Santa Monica, Calif.; Manned Spacecraft Center, Houston, Tex.; and NASA Representative at Massachusetts Institute of Technology, Boston, Mass.

Purchasing and Contracting Officer
U.S. Army Ordnance Missile Support Agency
U.S. Army Missile Command
Redstone Arsenal, Ala.

One each, system incremental digital data processing for automatic determination of load elongation data from Instrol Tension-Compression Testing Machine Model TTCH-1—Sole source to testing machine manufacturer because systems must be compatible with machine—RFP is not available.

Procurement and Contracts Office
George C. Marshall Space Flight Center
Huntsville, Ala.

Testing instrument. Deliver to George C. Marshall Space Flight Center,—1 item—IFB MSFC-63-9—Bid opening 8-13-62.

Procurement and Contracts Office
George C. Marshall Space Flight Center
Huntsville, Ala.

Design and Construction of a high-vacuum test facility at MSFC. It will be impractical to distribute the applicable criteria and drawings. This data may be examined at this center—Job—RFP not furnished—RFP due date 8-20-62.

Low-Altitude Air Defense Weapons System Div.
Industrial Directorate
U.S. Army Ordnance Missile Command
Redstone Arsenal, Alabama

Assembly and checkout of Hawk guided missile ground equipment. Period of performance will be six months, commencing 1 Oct. 62. Duplication of initial investment special tooling and facilities plus the nonavailability of dwgs and specs adequate to support competitive procurement precludes award to other than the prime contractor, Raytheon Co., Willow St., Waltham, Mass. All inquiries relative to subcontracting must be referred to Raytheon Co.

Bureau of Naval Weapons
Washington, D. C.

Contemplates award of a contract to the Raytheon Co., Waltham 54, Mass., for production quantities of Sparrow III missiles and associated items. Only this firm has immediately available the extensive and specialized facilities, special tooling and technical skills required to meet an early delivery deadline. This notice is made solely to inform potential subcontractors of the proposed procurement. RFP is not available. Small business firms and others interested in subcontracting should contact the above firm direct referencing CN 0070-63. Buweps synopsis No. 23-63.

ENGINEERS • SCIENTISTS

If you envision a future in

NUCLEAR ROCKETRY

consider a career with the

LOS ALAMOS
SCIENTIFIC LABORATORY

the leader in the field. LASL is expanding its ROVER test facilities and establishing a permanent organization at the National Nuclear Rocket Development Center near Las Vegas, Nevada. Opportunities exist for early affiliation with this fast growing program which is developing nuclear reactors for rocket propulsion.

ROVER FIELD TEST:

Several opportunities for B.S. to Ph.D. Physicists, B.S. to Ph.D. Electrical Engineers, B.S. to Ph.D. Nuclear Engineers, and B.S. or M.S. Mechanical Engineers.

At least 4 years' experience is required in one of the following areas:

Control Room Operations
Control System Design
Instrumentation and Data Analysis
Neutronics
Radiation Effects
Technical Review of Rocket or Reactor Test Facilities
Test Planning and Procedures

Employees will live in or near Las Vegas, but will be permanently assigned to work at the National Nuclear Rocket Development Center. Project Rover is operated by the Los Alamos Scientific Laboratory under the sponsorship of the AEC and NASA. Liberal compensation for extended work week in connection with field test work in Nevada.

* * * * * *

Also, some interesting and challenging positions are available at Los Alamos, New Mexico in the reactor design and development area.

ROVER DESIGN AND DEVELOPMENT:

Several opportunities for reactor specialists having a B.S., M.S., or Ph.D. degree in Mechanical Engineering, Nuclear Engineering, Civil Engineering, Aeronautical Engineering, Applied Mechanics, and Physics.

At least 3 years' experience is required in one of the following areas:

Reactor Test Analysis
Heat Transfer Analysis
Stress Analysis (preferably related to reactor design and structure)

The above work is to be performed for the Nuclear Propulsion Division at Los Alamos, New Mexico.

Employee benefits at both locations include:

★ **24 days annual vacation**
★ **8 paid holidays**
★ **Ample sick leave**
★ **Progressive retirement plan**
★ **Liberal salaries**

Laboratory representatives will be in attendance at the Nuclear Propulsion Conference in Monterey, California. For more information or for scheduling an interview while attending the Conference, call Mr. Robert Meier at Hotel Munras in Monterey (FRontier 5-2411), August 15, 16, or 17.

If inconvenient to call, send resume to

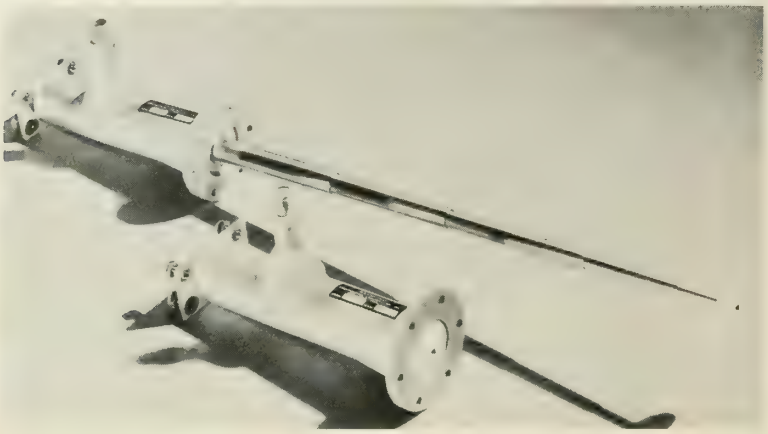
Recruiting Department

LOS ALAMOS SCIENTIFIC LABORATORY
University of California

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An equal opportunity employer. U. S. citizenship required.

Circle No. 7 on Subscriber Service Card



New Product of the Week: Whip Telescoping Antennas

EXPLOSIVELY ACTUATED whip telescoping antennas are available from Raymond Engineering Laboratory. The antennas consist of aluminum tubes of various diameters extended by an explosive cartridge in the base section. The tubes lock in position on tapered joints. Stored length is approximately one sixth extended, and the mounting configuration is adapted to the specification of the particular payload. The units range from 11 in. to 16 ft. in length.

Circle No. 225 on Subscriber Service Card

Portable Motor Alternator

A lightweight, portable motor alternator set that plugs into any standard 115-volt outlet and converts 115-volt, 60-cycle, single-phase power to 400-cycle, single- or three-phase power is available from General Electric's Specialty Motor Department.

Rated at 0.8 power factor, the set has a maximum output rating of 125 volt-amps. RMS harmonic content is 5% on the single-phase model, 3.5% on the three-phase model. Voltage regulation improves as unit is less loaded and as power factor approaches 1.0.

Circle No. 226 on Subscriber Service Card

IRD Vibration Selector

A portable, battery-operated instrument which measures and analyzes vibrations of rotating machinery is available from International Research and Development Corp., and H. H. Robertson Co. subsidiary.

The IRD Vibration Selector (Model 320) is used to test vibratory conditions of machinery as part of periodic preventive maintenance, to measure and analyze causes of increased machinery vibrations, and to improve quality control inspections and field service.

The filter covers most conventional machine speeds and is tunable from 500 to 15,000 CPM.

Circle No. 227 on Subscriber Service Card

Altitude Chambers

Altitude chambers featuring all-lucite construction have been developed by Associated Testing Laboratories, Inc.

Available in 18-in. and 24-in. cube working volume, the all-lucite chambers permit visual observation of the test specimen from the top and four sides of the chamber. Units are available in both the 100,000-ft. and 200,000-ft. altitude range and are supplied complete with a vacuum pump, vertical manometer, pressure switch and a McLeod gauge for the 200,000-ft. model.



Circle No. 228 on Subscriber Service Card

Polysonic Transducer

The diSONtegrator System 320P, a broad band frequency-modulated 5-gal. capacity ultrasonic cleaner with solid-state transducers is being marketed by UltraSonic Industries, Inc.

The System 320 is rated at 320 watts average power, 1280 watts peak input, fused for 7 amps, and operates from 117 volt-50/60 cycle line current. A 220 volt, 50/60 cycle export model is available.

Circle No. 229 on Subscriber Service Card

Ferrite Circulators

A wide range of compact, 3- and 4-port ferrite circulators, covering the frequencies from UHF to 9.6 Kmc, are available from Motorola's Solid State Systems Division.

Designed primarily for low-loss applications, such as parametric and tunnel diode amplifier assemblies, these solid-state devices feature temperature compensation and are available in either "Y" or "T" configuration.

Circle No. 230 on Subscriber Service Card

Multi-Purpose DC Amplifier

Neff Instrument Corp. has available the Type 106—a reliable, single-ended, multi-purpose, broad-band, solid-state d-c amplifier applicable as a line driver or for driving high-frequency galvanometers from the output of high impedance sources such as those associated with FM magnetic tape recording systems.

The type 106 offers frequency response to 25KC and contains its own internal power supply and operates from a 115 ± 10V, 60 cps source.

Circle No. 231 on Subscriber Service Card

Electronic Chopper

The Solid State Electronic Co. has available the Model 150 high-voltage, high-temperature, electronic chopper. This is an encapsulated plug-in unit designed to alternately connect and disconnect a load from a signal source. It is capable of linearly switching or chopping voltages over a wide dynamic range which nominally extends down to a millivolt and up to ± 150 volts. The unit can handle up to 5 milliamperes.

The Model 150 is practically immune to the effects of shock and vibration, and hence is ideal for military, missile, and portable applications, or where power conservation, miniaturization and elimination of maintenance are a necessity.

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IF Amplifier

A series of miniature IF amplifiers in 3-D welded-module configurations, has been developed by Micromodular Components, Inc.

Featuring a power gain of 25 db. per stage at center frequency, the 10.7 MC amplifiers have a 400 KC bandwidth and may be specified with fixed or variable tuning. Designated the WA series, the units have output and input impedances of 50 ohms with noise figures at center frequency less than 10 db.

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Sensitive Dosimeter

Metcom, Inc., has available a sensitive dosimeter and read-out unit which is based on the thermoluminescence property of manganese-activated fluoride crystals which will "trap" electrons displaced from their normal positions from radiation, in the solid-state lattice structure.

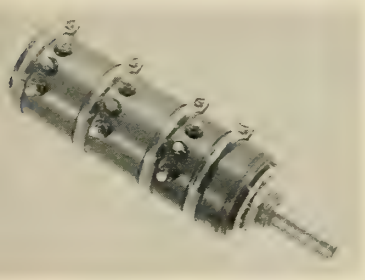
This phenomenon is sensitive to X-rays and gamma-rays as well as other nuclear emanations. The crystals can be neutralized after they have been read.

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Push-Pull Model Potentiometer

A miniature Push-Pull Model 18GJ which provides the independent action of three potentiometers in the normal space requirement of only one.

Each potentiometer of the Model



18GJ can be set frequently and quickly without disturbing the other settings. No screwdriver or other setting tool is needed to operate the unit, which is set by pushing the shaft to set first, rotating shaft to set second and pulling shaft to set third potentiometer.

Circle No. 235 on Subscriber Service Card

EX-1 Scaler

Tiro Laboratories, Inc. has available Model EX-1 Scaler, a compact programable voltage divider useful for a wide variety of test instrumentation applications.

The scaler has an overall resistance of 1 megohm, with division taps providing voltages of 1, 0.1, 0.01, and 0.001 times the voltage applied across the divider, to an accuracy of ± 0.05%. The taps may be programed manually by means of an edge-mounted thumbwheel on the front plate, or remotely and/or automatically by external circuit closures connected to a set of terminals at the rear of the module. In addition to the divider function, the scaler offers a manual or remotely-programed selection of precise (± 0.05%) absolute resistance ratios, suitable for use in bridge applications. The circuit has a maximum voltage rating of 300 volts (peak) a temperature coefficient of ± 5 parts per million/°C maximum.

Circle No. 236 on Subscriber Service Card

Sub-Min Attenuators

Microlab is marketing a lightweight, miniature fixed attenuator series designed for systems where size and weight are at a premium.

They may be custom-made to fit special installations. Attenuation valves can be chosen from 1 to 60 db through a frequency range of d-c-2500 mc. Maximum VSWR is typically 1.3:1 (depending on connector style), average power 1 watt, and peak power 1Kw.

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Bellows-Actuated Gauges

The bellows-actuated gauges developed by Kunkle Valve Co., Inc., provide sensitive and accurate (within 1%) pressure readings within ranges of 8 oz. or 15 in. to 12 psi or 30 ft. The gauges are available in a large variety of standard cases for applications in pressure, vacuum or compound service with air, gas, or liquid media.

Circle No. 238 on Subscriber Service Card

Free Gyro-System

Telecomputing Corp. has developed a miniaturized roll-stabilized free gyro system which provides pitch, roll and yaw attitude information for telemetry or control of spinning rocket vehicles, easily adapted to spinning orbital vehicles and nose-cone re-entry studies for either control or telemetry. Two two-degree-of-freedom gyros are mounted on a roll-attitude stabilized platform. One gyro senses and corrects roll position errors of the platform through a servo system and provides yaw attitude information. The second measures pitch attitude. Potentiometer pick-offs provide convenient data output. Operational freedom angles are: pitch 360°, roll 360°, and yaw ± 85°. Maximum gyro drift does not exceed 0.5°.

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Leak Detector

Vacuum Instrument Corp. has available MD-140 mass spectrometer leak detector with built-in auxiliary evacuation system—featuring a sensitivity of



5×10^{-14} std. cc./sec. The increased sensitivity is attained through the mass spectrometer principle combined with differential sorption or a sorpitron tube. A highly concentrated, essentially clean inert gas mixture enters the ionization portion of the spectrometer tube, permitting a much more stable amplification of the most minute signals.

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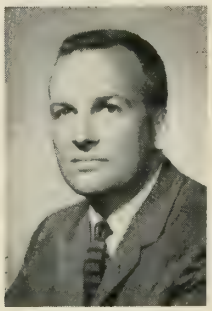
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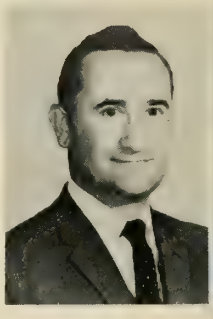
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Donald S. Lewis: Elected president and chief operating officer of McDonnell Aircraft Corp., St. Louis.

John G. Fitzpatrick: Appointed vice president of Autonetics, a division of North American Aviation, Inc., Downey, Calif.

James J. Halloran: Promoted to executive vice president of Electro Engineering Works, San Leandro, Calif.

Yale Barken: Named manager of systems engineering of the electronic systems division of Telecomputing Corp., Los Angeles.

Frank Enge: Appointed chief engineer for the Ford Instrument Co., Long Island City, N. Y.

Dr. Elred C. Nelson: Appointed director of the programing and applied mathematics laboratory in Space Technology Laboratories, Inc.'s Computation and Data Reduction Center, Redondo Beach, Calif.

Charles E. Sporck: Named operations manager of Fairchild Semiconductor, Mountain View, Calif.

Herbert G. Ayers: Appointed general manager at California Technical Industries, Belmont, Calif.

Norbert C. Vojta: Joined Dalmo Victor Co. Div. of Textron, Inc., Belmont, Calif., as manager of marketing.

Frank E. Pilling: Appointed vice president and assistant general manager of the Marvel-Schebler Products Div. of Borg-Warner Corp., Decatur, Ill.

H. Wayne Priest: Promoted to general manager of the Western Div. of Stratoflex, Inc., Fort Worth, Tex. **H. Ray Morgan** promoted to southeastern district manager in Atlanta. **A. J. Bowie** named sales manager of the Western Div.

Ordway B. Gates, Jr.: Named deputy technical director for systems engineering for the Martin Co.'s Space Systems Div., Baltimore.

W. Mason Shehan: Appointed senior representative for Northrop Corp.'s Ventura Div., in the eastern district office, Washington, D. C.

Andrew Georgia: Elected vice president of planning of Belock Instrument Corp., College Point, N. Y.

David Gerstein: Named executive vice president of the Data & Controls Div. of Lear Siegler, Inc., Long Island City, N. Y.

Edward E. (Pete) Clark: Named manager of advanced lunar programs for scientific manned space projects at North American Aviation's Space and Information Systems Div., Downey, Calif.

William B. Nicholson: Elected a vice president of Union Carbide Corp., New York, N. Y. **Robert F. Flood** appointed president of the Linde Co., a division of the corporation.

Rowland M. Younger: Named director of the logistics department of Martin's Electronic Systems & Products Div., Baltimore.

Walter R. J. Brown: Appointed director of exploratory development for United-Carr Fastener Corp., Cambridge, Mass.

William E. Maschal: Named assistant general manager-management systems, Douglas Aircraft Co., Santa Monica, Calif.

J. O. Charshafian: Appointed president of PRL Electronics, Inc., Rahway, N. J.

Edward S. Chalpin: Appointed product development manager of Metal Bellows Corp., Wellesley, Mass.

Stuart L. Dance: Promoted to vice president-marketing, of HRB-Singer, Inc., State College, Pa. **Charles W. Doerr** appointed vice president-marketing.

Dr. Michael M. May: Appointed associate director of the Lawrence Radiation Laboratory at the University of California.

Dr. Franklin E. Lowance: Joined the Military Products Div. of Hoffman Electronics Corp., Los Angeles, as chief scientist.

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Society of Photographic Instrumentation Engineers, Seventh Annual Symposium, Statler Hilton Hotel, New York City, Aug. 6-10.

Low-Level Wind Conference, sponsored by American Meteorological Society and U. S. Army Signal Missile Support Agency, Texas Western College, El Paso, Tex., Aug. 7-9.

57th Meeting, National Aerospace Standards Committee, Aerospace Industries Association, Benjamin Franklin Hotel, Seattle, Aug. 7-9.

1962 Standards Laboratory Conference, National Bureau of Standards Boulder Laboratories, Boulder, Colo., Aug. 8-10.

Institute of the Aerospace Sciences, Man-Machine Competition, Olympic Hotel, Seattle, Aug. 10-11.

Pacific Energy Conversion Conference, American Institute of Electrical Engineers, Fairmont Hotel, San Francisco, Aug. 13-16.

International Science Writers Seminar, sponsored by American Institute of Physics with the cooperation of the American Institute of Biological Sciences and American Chemical Society, Seattle, Aug. 13-16.

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BOEING

Giant with a Rabbit

SOMETIMES a profound event touches off a train of philosophical speculation which extends even beyond its own import. Such an event was the death on July 26 of J. H. (Dutch) Kindelberger, chairman of North American Aviation.

Kindelberger was one of the giants of his industry, a man whose creative engineering and management genius covered a span from the days of primitive aircraft to the initial stages of lunar landing expedition.

Yet someone knowledgeable in the missile/space industry asked the other day: "Who was he?"

Nothing could more dramatically illustrate the change in what used to be just an airframe industry, a change in which Kindelberger himself played a major role.

There are vast segments of the missile/space industry—electronics, propulsion, chemistry—where the names of the giants of the aircraft industry are but faint echoes. Some airframes companies still exist only as a segment of the newer and broader industry.

But Dutch Kindelberger and his partner in NAA management, President J. L. Atwood, evolved North American into a broadly based firm that today covers all major branches of the missile/space industry.

Kindelberger is quoted as saying: "Nobody ever pulled a rabbit out of a hat without carefully putting it there in the first place."

Kindelberger was adept at placing rabbits in hats.

The early part of his professional career was as chief draftsman for Glenn L. Martin Co. and as vice president and chief engineer for the Douglas Co., where he participated in design of the famed Douglas DC transport series.

One of his first rabbits when he joined North American was to move the company from Maryland to California. Out of the relocated firm came military aircraft which World War II pilots still remember as some of the sweetest-flying machines ever built: the Mustang, the Mitchell and the Texan.

This tradition continued with Korean-war-vintage jet aircraft, the Sabre and Super-Sabre. But the end of World War II offered a new management challenge that was muffed by many and adroitly fielded by Kindelberger.

He began moving NAA into the fields of missiles, nuclear energy, space, electronics and propulsion. What followed is history. North American became a major power in the new industry, doing over half a billion dollars in missile/space business last year. It is the leading NASA contractor; second only to General Dynamics in Department of Defense contracts.

With this change in the company came a change in the nature of government/industry relationships. Although he was adroit in meeting them, not all of these changes won the approval of the big, gruff man who bossed North American until his health began to fail over a year ago.

When Dutch Kindelberger began his career, individual initiative counted for a great deal in the success of an aircraft company. One of his beliefs was that a competent design team frequently could tell the military services what they needed and then sell it to them.

Those days are no more. Projects are too vast, too costly for such speculative investment. Only rarely now can a company sell a new idea to the government. The government maintains a great number of profit and non-profit relatives to help it make the technical and management decisions on what to buy and when. The rare firm selling a new idea is lucky indeed if the production contract doesn't go to someone else.

Roaring, free-wheeling private enterprise is going the way of the wooden prop, the helmet and the white scarf. Something rather more frightening is taking its place. Great pools of brainpower in the industry now must be devoted to figuring out what the government is *going* to do, rather than what it *ought* to do.

In this atmosphere, the appearance of such a strange document as the Report to the President on Government Contracting for Research and Development makes scarcely a ripple. We mentioned this in an earlier editorial (M/R, July 9, p. 46). It is worthy of further attention. Here is one quote:

"Contract policies respecting salaries and related benefits in each contracting agency should be controlled by an official reporting directly to the head of the agency (in the Department of Defense, to assure uniformity of treatment, by an official reporting directly to the Secretary of Defense), and salaries above a certain level—say $25,000—should require the personal approval of that official."

President Kennedy asked the reporting group to focus on, among other things, "the policies, if any, that the government should follow in controlling the salaries and fringe benefits of personnel working under a contract, and the *appointment, management and dismissal of such personnel.*"

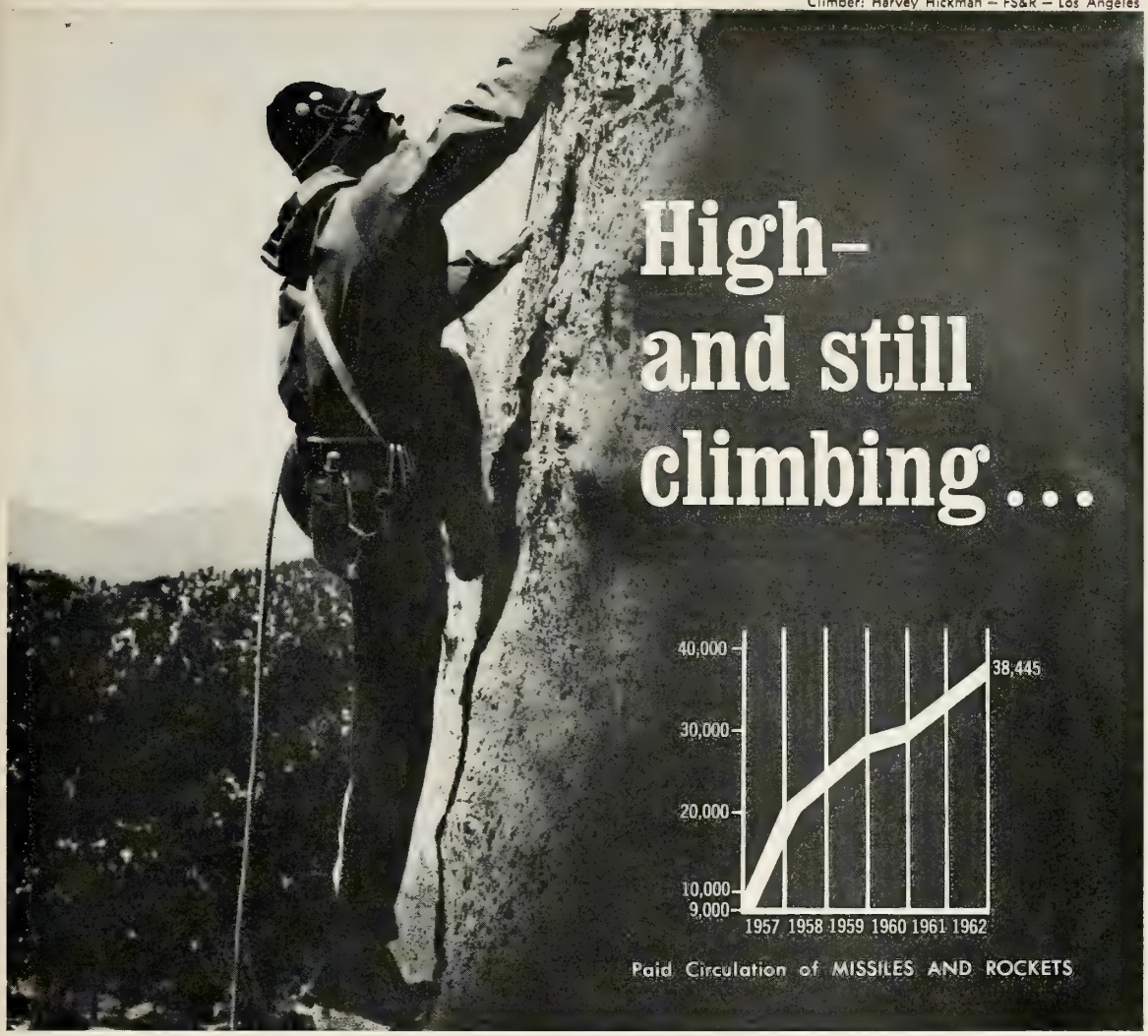
THE IMPLICATIONS are ominous. In many areas, the report is non-responsive to the President's directive (including the fact that he asked for it by Dec. 31 and didn't get it until April 30). In many areas, it is naive. But its very childishness makes it even more dangerous. This vague, socialistic document commonly has been referred to as a Bureau of Budget report but it is significant to note that it is signed by Defense Secretary McNamara, NASA Administrator Webb, Atomic Energy Commission Chairman Seaborg, National Science Foundation Director Waterman, Presidential Special Assistant Wiesner, and Civil Service Commission Chairman Macy, in addition to Budget Director Bell.

Coupled with new DOD studies on placement of defense contracts in depressed areas, the report makes it clear how little the government understands the proper functioning of this industry.

The lonely hum of a biplane has been replaced by the roar of a great rocket rushing moonward. But we doubt if Dutch Kindelberger loved the industry he left as much as the one he entered.

The adventure and challenge still are here but rabbits are mighty hard to find these days.

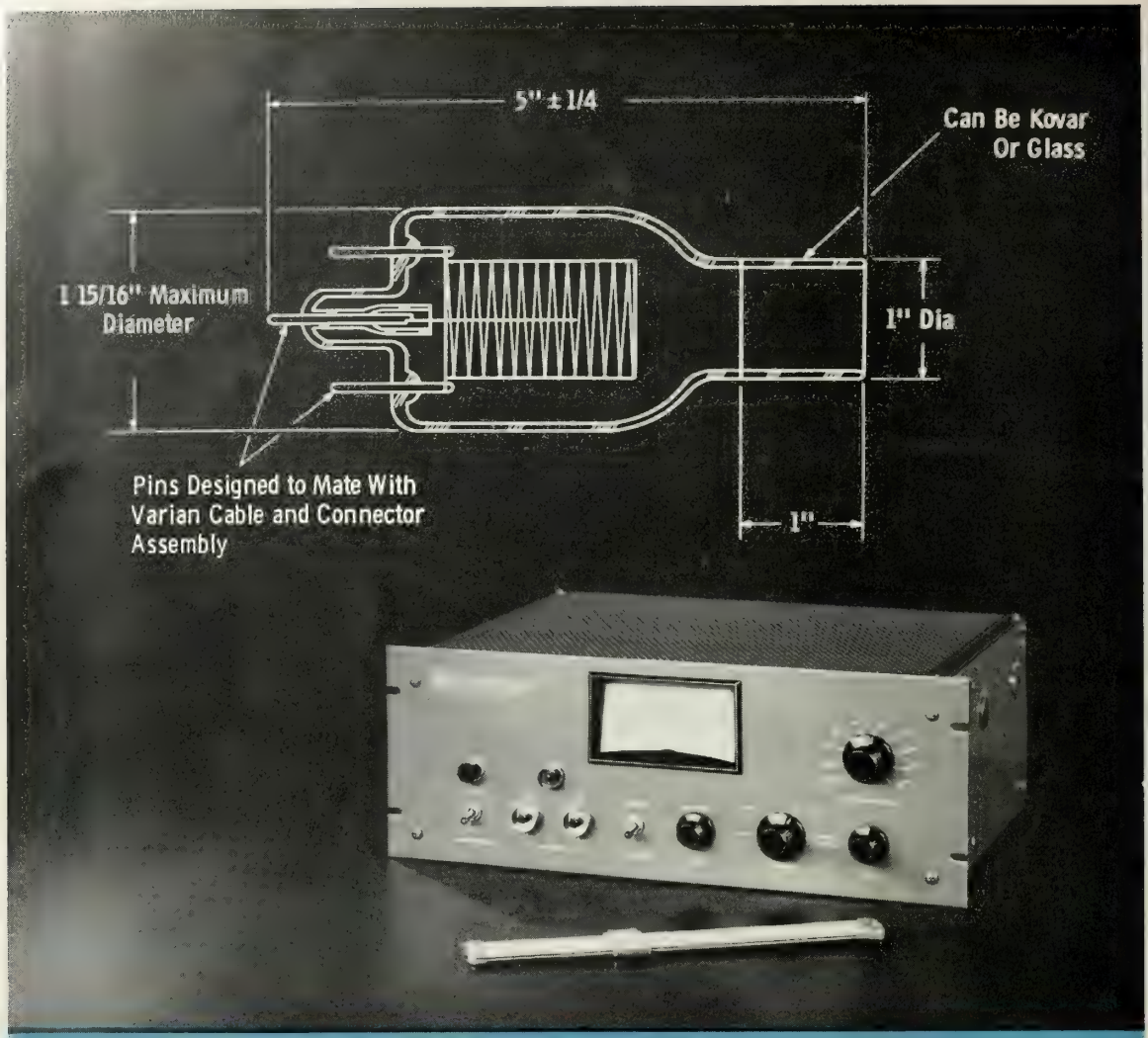
William J. Coughlin



MISSILES AND ROCKETS' advertiser benefits continue to increase as 2,607 unsolicited new paid subscriptions were gained the first 135 days of 1962. And M/R's ABC audited circulation is concentrated where major missile/space buying decisions are made: 11,506 paid subscribers are in the leading 40 companies which accounted for over $14 billion in missile/space contracts during 1961.

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AUGUST 13, 1962

missiles and rockets

THE WEEKLY OF SPACE SYSTEMS ENGINEERING

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Bids on LLSV Studies Expected Next Week

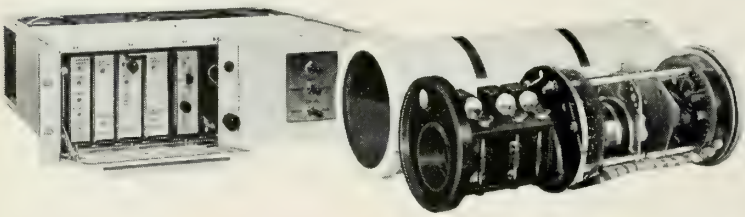
- **Big Solid Awards in 60 Days?**
- **Polaris Moves Into A3 Phase**
- **Goodyear's Space Structure**

First Photo of Polaris A3

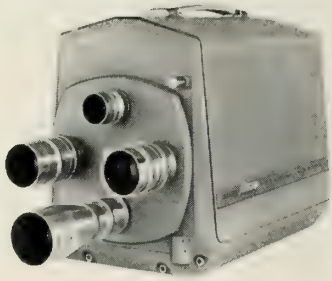
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KIN TEL's 1995 TV System



KIN TEL's 20/20 TV System

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The 20/20 system consists of a self-contained camera that provides clear, 650-line resolution pictures and works with any TV monitor—with accessory, you can even use the TV receiver you have in your home. So sensitive, you get usable pictures with less light than is falling on this page. Low, 25 watt power consumption; easy-to-service, swing-out circuit boards; and transistor circuits make for trouble free operation.

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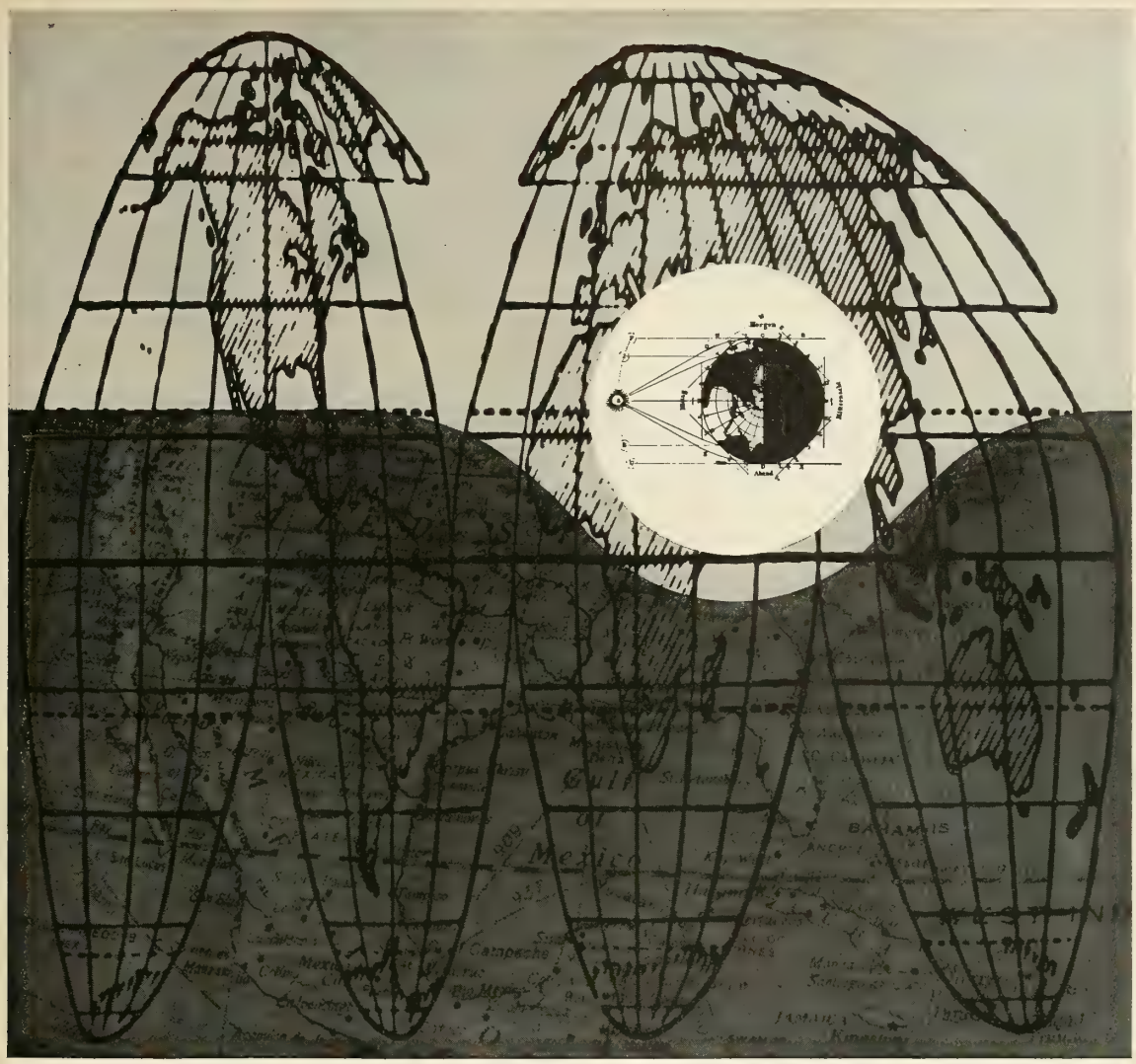
A wide variety of accessories for both systems lets you "custom build" a TV system to fit your particular needs, no matter how involved. For example: a light compensation circuit adjusts the camera for light variations as great as 4000:1. Motors provide remote control of the lens turret, focus, and a lens-speed filter. Sync generators provide 2:1 interlace either in the standard E.I.A. sweep/scan pattern or in the *Fineline* pattern that gives you greatly increased vertical resolution. A Westinghouse PERMACHON tube lets you retain the image at any time for up to 5 minutes. Pan/tilt units permit remote control of camera to cover subject action on horizontal or vertical planes.

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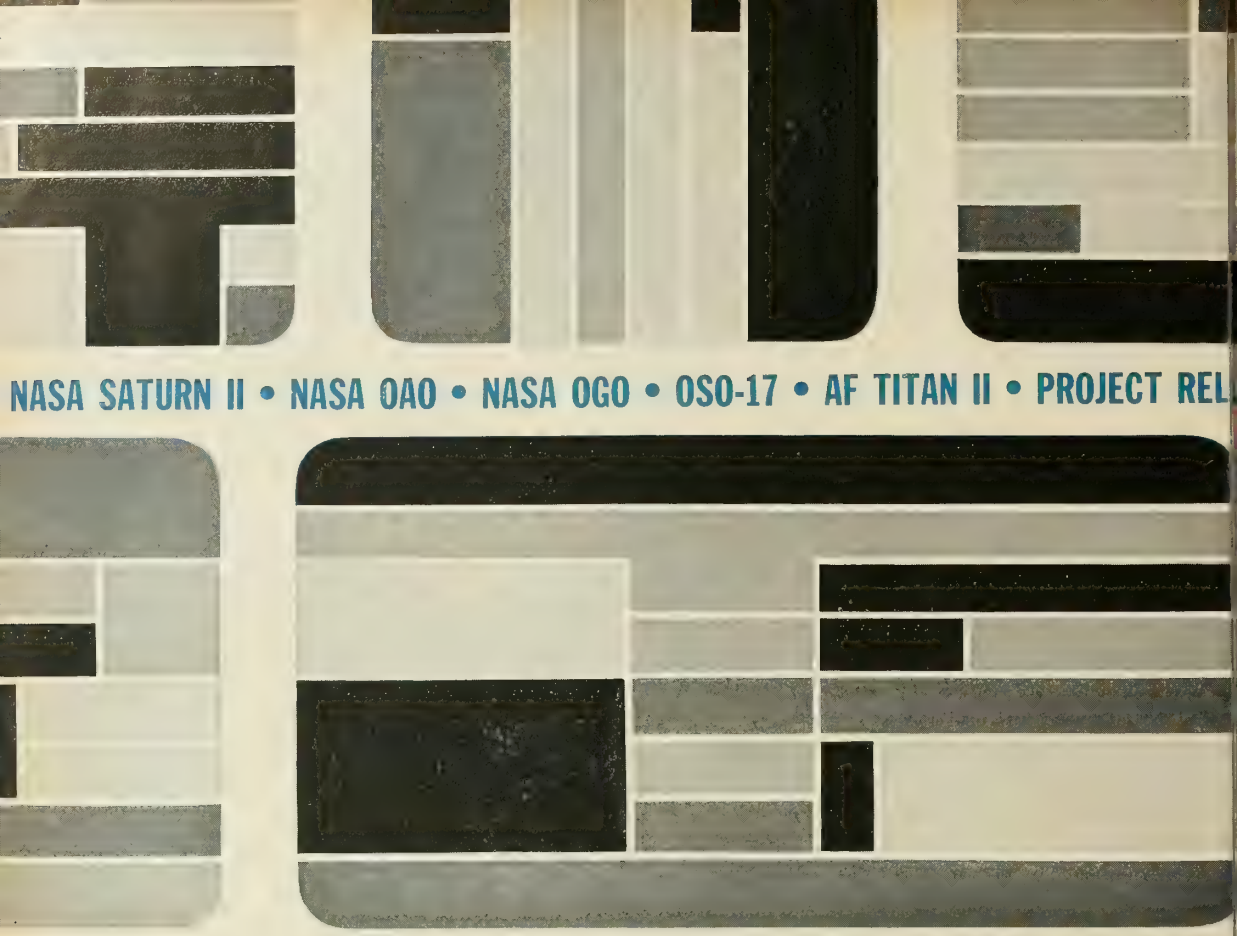
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THE WEEKLY OF SPACE SYSTEMS ENGINEERING

missiles and rockets

Volume 11, Number 7 August 13, 1962

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THE COVER

First released photo of Polaris A3 configuration shows Lockheed missile on its pad at Cape Canaveral prior to partially successful Aug. 7 maiden firing. See p. 15.



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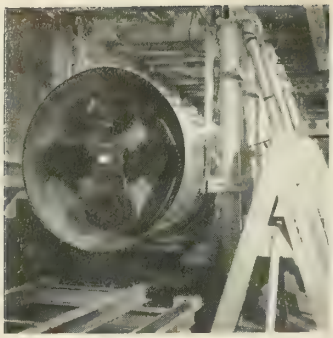
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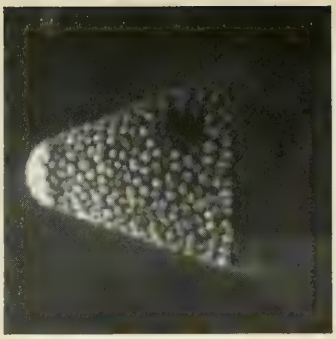
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Missile Structures



Re-entry Materials



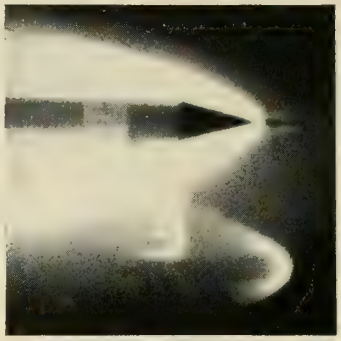
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Radio Frequency Interference Studies



Life Sciences



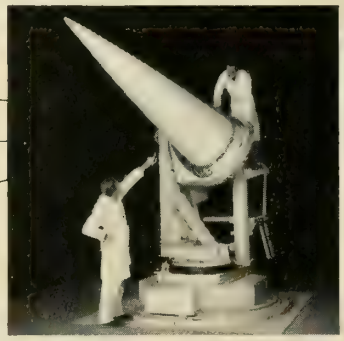
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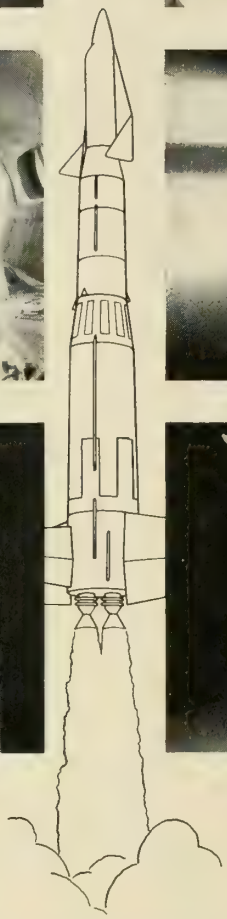
Solar Power Studies



Space Flight Paths



Guidance and Controls



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Emphasis on quality and reliability has contributed toward the Division's outstanding record of performance in systems management. It has also assured the design and development of superior products, manufactured and delivered on schedule, at lowest cost.

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letters

A Covey of Skybolts

To the Editor:

Much as I enjoyed M/R's July 30 Sixth Annual World Missile/Space Encyclopedia, I couldn't resist writing to tell you that the "*Quail*" decoy missiles appearing (according to the caption) on page 74 bore a striking resemblance to the *Skybolt* missile. But that's just one of the hazards of knocking out a paper once a week. Now it's your turn to needle me the next time I goof.

John Rhea
Defense & Aerospace Systems
Electronic News
New York

Skybolts they are. The errant Quail was flushed out of some, but not all of the copies of the issue.—Ed.

Profit in Misutilization?

To the Editor:

For several years I have watched the continuing discussions of engineering shortages and poor engineering utilization, provided in letters to magazine editors and in editorials. Many of the comments have come from educators who want to increase their importance, and from engineering company managers who want to increase the stock of engineers to reduce their price.

As an engineer who has been employed by an aerospace firm for over 10 years, I have been amused by the many answers to "the shortage of engineers," claimed by everybody but the engineers; and the "poor utilization" claimed only by the working engineer.

I have delayed making my comment in hopes somebody else would present it better than I can. Now I feel I must comment, although it is not in my own best interest.

At one time I was very puzzled by the way engineers are hired, stockpiled, and utilized in companies which are primarily doing government R&D work. Everything is efficient in an aerospace firm except engineering. I thought at first it was just the result of rapid growth and the problems of R&D operations where engineering was pushing the state of the art forward. Most engineers still feel this is the reason.

I was also puzzled by the rejection by upper management of suggestions which would improve engineering utilization. This reluctance to make simple, obvious changes suggested that a profit motive might be the reason for poor utilization of engineers.

I started to hunt for a way to make a profit by poorly utilizing engineers. I soon found one. It was packaged in the method of defining and paying for engineering costs on government contracts.

Here is how it is done.

An R&D project is a hard thing to price. It is difficult to decide how many engineering hours will be required to actually get an R&D item into production on a selected schedule. To try and solve this problem, government contractors have arranged that the government agency pay the cost of engineering through an engineering charge related to the actual engineering hours used. This charge has usually been negotiated to a figure of about $10 to $14 per engineering man-hour. This is supposed to pay for the following:

1. Engineer's actual salary and fringe benefits; 2. Cost of *adequate* supervision; 3. Cost of *adequate* engineering support services; 4. Cost of *adequate* engineering working area.

The value of this engineering charge is established by defining *adequate* in terms of what is usually required to get efficient employee performance. It is usually standardized—the same for each government contract and for different contractors . . .

Now, if you were looking for a way to gain extra profit from an R&D contract, wouldn't you try to pocket as much of the engineering charge as possible? And if you could pocket about $1.08 out of every engineering hour charged, wouldn't you try to use more engineering hours?

Aerospace contractors get about $1.08 out of every engineering hour charged to a government contract by: 1. Holding down engineering salaries; 2. Reducing costs by having less than adequate supervision; 3. Reducing costs by having less than adequate engineering support services; 4. Reducing costs by providing less than adequate engineering working areas; 5. Providing red tape so that engineering charges are increased; and 6. Utilizing as much overtime as possible.

There you are! Now, check engineer comments about working for companies with government R&D contracts. It all adds up. Poor engineering utilization makes a profit, above and beyond the negotiated profit expected as a usual fee.

The shame is that engineers are being wasted when so much challenging work could be done. And the taxpayer is getting short-changed. I leave it to your reporters to dig further into this subject. It could make some interesting news.

Name Withheld

Wandering Prefix

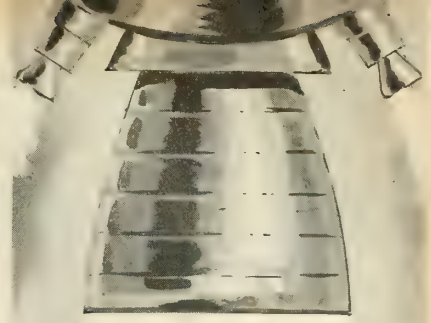
To the Editor:

In my letter to the editor ("The Urge to Merge," Letters, M/R, July 16, favoring ARS-IAS merger as a means of reducing the number of "marginal" meetings), the last line was erroneously reproduced. It should read:

"The urge to merge should ablate the potential *dis*advantages to insignificance."

C. C. Miesse
Astronuclear Laboratory
Westinghouse Electric Corp.
Pittsburgh

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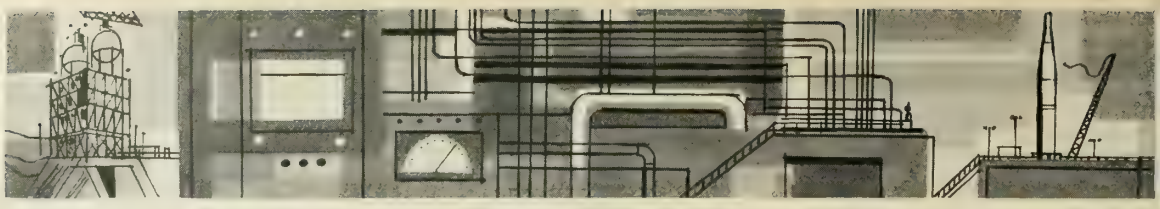
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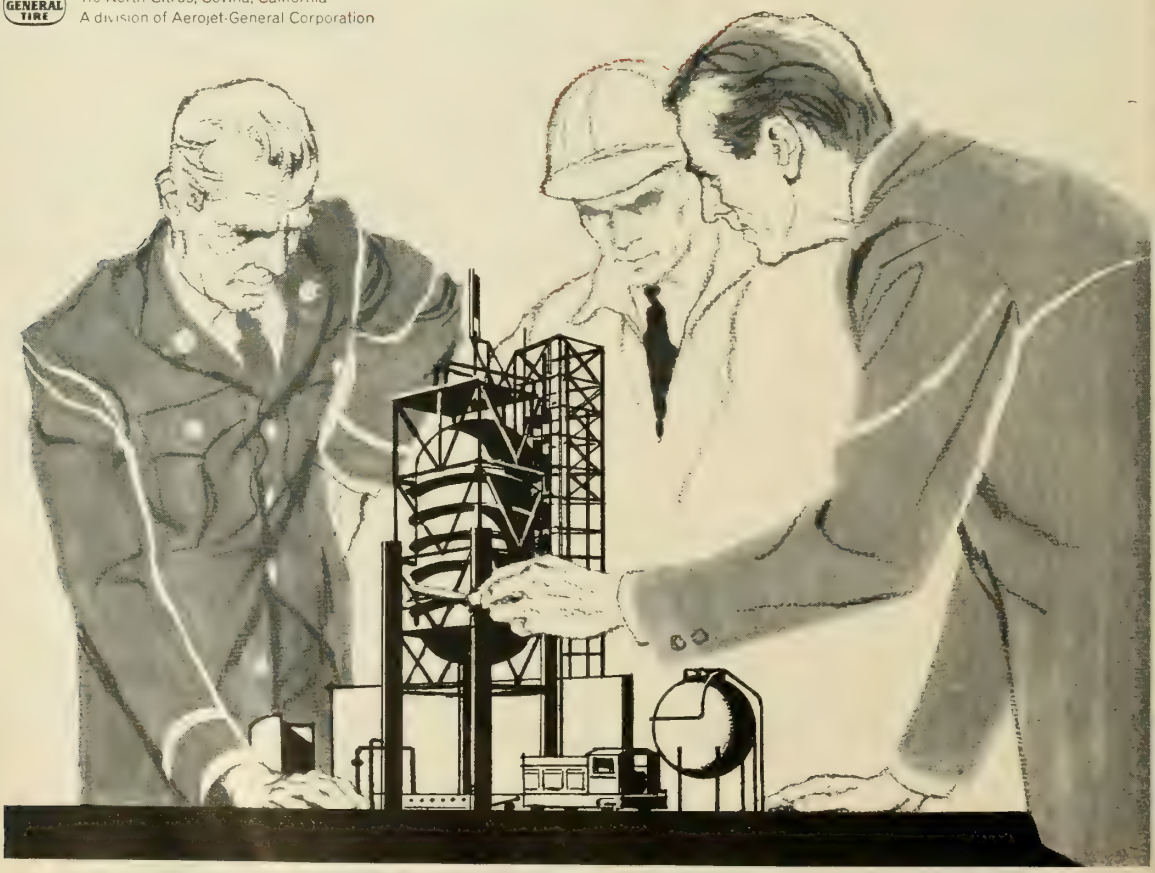
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The Countdown

WASHINGTON

Hughes Wins TOW Competition

Hughes Aircraft has won the three-way competition for the Army's *TOW* antitank missile, following tests conducted at Aberdeen Proving Ground. Other entrants: Martin and McDonnell. Contract plans have not been announced.

Surveyor Reduction Is Studied

NASA still is considering a possible reduction in size of the *Surveyor* spacecraft to bring it within the boost capability of the *Atlas-Agena*. But insiders say the fact that *Surveyor* is slipping almost as badly as its *Centaur* launch vehicle probably will rule this out. Optimistic target date now is late 1964.

House Advent Hearings Scheduled

House Space Committee will hold public hearings this week on the reoriented Department of Defense *Advent* communications satellite program. Purpose: to determine whether duplication exists between the new program and NASA's *ComSat* programs.

Mariner Scheduled for This Week

NASA will try again with its *Mariner* Venus probe on Aug. 17. Guidance equations have been reworked. The July 22 shot failed when the *Atlas-Agena* booster veered off course and was destroyed. Omission of a single hyphen in the guidance equations was blamed. Other shots scheduled in a busy week: *Atlas F* R&D flight with a *GYPSE* pod on Aug. 13, second attempt to launch the *ANNA* geodetic satellite on Aug. 15, a *Scout* launch on Aug. 19 from Wallops.

NASA Money Approval Still Pending

NASA's Fiscal '63 appropriations will not be finally approved by Congress for another two or three weeks. Testimony by NASA officials before the Senate Appropriations Committee began late last week. This is to be completed this week but Senate approval will require at least another two weeks.

Bigger NASA Role in ANNA

A bigger role in the *ANNA* geodetic satellite program is in the wind for NASA. House Space Committee recommended that the space agency take it over completely. But NASA officials are shying away from any comment until they see what action the Navy, current program manager, will take.

Contract Pending on Lunar Craft

NASA still has not decided what type of study to initiate on its proposed two-man spacecraft for direct flight to the Moon. The snag: should it be an in-house study, an industry contract or a combination? Decision is expected in two weeks.

INDUSTRY

Future Dim for Patent Bill

Don't expect any definitive action on new patent legislation. The House Space Committee has again reported out a bill on NASA patent policies. The Senate committee still is uninterested, however. Even if passed by the House, the bill will die in the Senate.

Hughes Gets TFX Missile Contract

Predevelopment contract to refine design details and cost/performance specifications on the Navy air-to-air missile system for the new TFX aircraft has been awarded to Hughes Aircraft. Specification details for the missile itself also are covered by the award.

Mauler Going to Sea

Preliminary development program to adapt General Dynamics/Pomona *Mauler* Army field missile to Navy ships now is under way. Navy will install the solid-fueled surface-to-air missile on beach assault craft. Sea-going version is dubbed *Sea Mauler*.

UTC Gets New Research Contracts

United Technology Corp. has received five new research contracts totaling more than $1 million in the past month. Details have not been announced but they involve high-energy and advanced propellant research and hybrids. Company is expanding and modifying its propellant R&D facilities to handle the programs.

Contract Near on Missile-Carrying F-5A

Contract negotiations between Northrop and Air Force on production of the missile-carrying F-5A supersonic jet fighter (formerly the N-156) are near completion. Fighter can haul more than 5000 lbs. in air-to-air or air-to-surface missiles, including *Bullpup, Sidewinder, Falcon, Genie* and others. First deliveries of the aircraft, selected for countries in the Military Assistance Program, are due 14 months after production go-ahead.

Titan III Go-Ahead Expected

Industry sources say the *Titan III* program package now is on Defense Secretary McNamara's desk awaiting final approval. The DOD boss has been briefed by his research and engineering chiefs on the program. Air Force, meanwhile, is working out final details of the 120-in. solid booster contract with United Technology Corp.

INTERNATIONAL

Russians May Have Laser Weapon

Soviet Union may be pushing strenuously on development of a high-energy laser beam as a space weapon. That's the warning from Air Force Gen. Bernard A. Schriever, head of Systems Command. He says lasers could have destructive and lethal effects able to degrade or destroy sensors and structures of a space vehicle.

British Missile Review Under Way

Review of Britain's missile program now under way by the new Cabinet could lead to cuts which would wipe out the market potential for *Sergeant* and even *Skybolt*, although latter seems unlikely.

Shots of the Week

The rocket-powered *X-15* was deliberately flown into sideslips Aug. 2 by NASA test pilot Joseph Walker in a backup flight aimed at testing the automatic stability corrections engineered into the plane after Air Force Maj. Robert White experienced yaw problems in achieving his record 60-mile altitude. W. lker's successful flight paved the way for a possible 75-mile push with the craft. An Aug. 8 flight of the *X-15* subjected the craft to severe temperatures in what was described as an experiment to gain information for flights of "high-design space vehicles." AF Maj. Robert Rushworth flew the ship through an 80° bank and a series of roller coaster tactics so that it would be "sprayed" with hot air from different angles. Peak temperatures registered were said to be hot enough to destroy a conventional plane and pilot.

• On Aug. 5 the Air Force launched a package with an *Atlas-Agena* system from Pt. Arguello, Calif. It was presumably a *SAMOS* or *MIDAS*, but the AF provided no further information.

• On Aug. 7, the Navy shot down a *Regulus* with an air-launched *Sparrow* off Pt. Mugu, Calif. The McDonnell *Phantom* fired the Raytheon *Sparrow* at the jet-powered drone at an undisclosed distance and altitude, completely destroying the guided-missile target. (See p. 15.)

• A bullet-shaped *Polaris A3* was launched from Cape Canaveral for the first time Aug. 7. It travelled successfully through its first stage, but suffered a second-stage malfunction. The *A3* has an ultimate range of 2880 miles but fell far short of its intended 1995-mile flight this time. The Navy termed the test a "partial success." (See p. 15.)

• A steel sphere designed to check certian ionospheric characteristics was launched from Eglin AFB on Aug 3. The *EXOS* vehicle pushed the probe to a 45-mile altitude and the payload coasted the rest of the trajectory, gathering charged particle density and temperature data.

• Sweden successfully launched a *Nike-Cajun* Aug. 7 to investigate clouds and the Northern Lights in collaboration with 10 U.S. specialists.

Nuclear Gyro Tests Advance

Development of the first effective nuclear gyro—perhaps signalling a dramatic advance in submarine, missile and spacecraft guidance—may be in the works at Republic Aviation Corp.

The company says preliminary experiments on the magnetic induction gyro have verified earlier theoretical predictions of high sensitivity, extremely low drift rates, and relatively simple mechanical design.

A nuclear gyro, in effect, removes the traditional spinning mass and relies upon the inherent spin and associated magnetic movements of protons and electrons. The protons' resistance to turn despite rotation of their encompassing magnetic field generates an electric current which basically reflects the vehicular direction change. Republic is doing the work for the Navy's BuWeps.

ComSat Fight Renewal Seen

The satellite communications bill neared the Senate floor for the second time late last week bolstered by support from key Kennedy Administration officials.

Despite the favorable testimony in the Senate Foreign Relations Committee hearings, Democratic Leader Mike Mansfield said he was expecting "the worst" from the handful of liberal Democrats who blocked the bill with a filibuster for nearly a week the first time it reached the Senate floor.

The bill calls for establishment of a corporation to administer U.S. participation in the projected world satellite communications system. Ownership would be divided equally between the communication companies and the public.

Sen. Wayne Morse led the earlier filibuster until a compromise allowed the bill's referral to the Foreign Relations Committee. Morse contends the bill would give rise to an A. T. & T. monopoly.

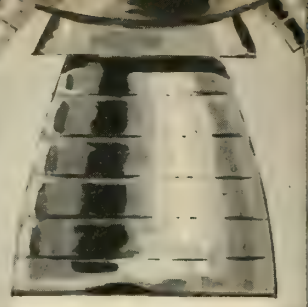
Despite the liberal bloc opposition, Democratic Whip Hubert Humphrey said he was confident the bill still has about an 80-20 margin of Senate support.

Others who testified before the Foreign Relations Committee in favor of passage of the bill included Attorney General Robert Kennedy, Secretary of State Dean Rusk, Secretary of Defense Robert McNamara and Deputy NASA Administrator Hugh Dryden.

The attorney general said the compromise between government and private control of the corporation is "most acceptable." He testified that it protects both the foreign policy position of the Government and the public position.

Rusk stated "most emphatically" that

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the foreign policy provisions of the bill do not delegate to the corporation a part of the President's authority to engage in international negotiations on behalf of the U.S., as the bill's opponents had suggested.

McNamara testified that the Pentagon "strongly supports the objective of establishing a civil communications satellite system as expeditiously as practicable." He said that while the Defense Department will have to supplement the civil system with a military system to meet specialized military requirements, the civil system will provide "significant improvements in our military communications."

AEC Vacancies Filled

James T. Ramey and John G. Palfrey were nominated by President Kennedy to the Atomic Energy Commission.

The appointments will bring the five-member body to full strength for the first time since the July 1 resignations of Loren K. Olson and John S. Graham.

Palfrey leaves his post as dean of Columbia College, New York City, to succeed Olson. Ramey has been serving as executive director of the Congressional Joint Committee on Atomic Energy *(see editorial, p. 54)*.

NASA Moves to Aid Industry

NASA has established an Industrial Applications Advisory Committee to assist in transferring new scientific and technological knowledge from the space agency's research and development program to industry.

Earl P. Stevenson, former president and chairman of the board of Arthur D. Little, Inc., engineering and industrial research company, has been named committee chairman.

Objective of the Committee will be:

- To recommend methods for identification, retrieval, evaluation and dissemination of innovations having high potential for industrial applications.
- To assist in development of procedures for the most effective transfer of technology from NASA research and development programs to the industrial community.

Administrator James E. Webb noted that much of the extensive new knowledge developed in the nation's intensive space R&D is of value for practical commercial application in the civilian industrial economy.

"It is our objective, in accordance with directives given to us by Congress and the President in creating NASA, to insure that developments resulting from NASA's scientific and technological programs be retrieved and made available to the maximum extent for the nation's industrial and consumer benefit in the shortest possible time," Webb said.

Other members of the Industrial Applications committee are James Hillier, vice president, RCA Laboratories, Princeton, N.J.; Malcolm M. Hubbard, former vice president-technical and director of research, ITEK Corporation, Cambridge, Mass.; Dr. Emanuel R. Piore, vice president-research and engineering for International Business Machines Corportation, New York City; James Slayter, vice president-research, Owens-Corning Fiberglass Corporation, Granville, Ohio; Frank W. Godsey, former president of Electronic Communications, Inc., St. Petersburg, Fla.; Edmund F. Buryan, former president of MOTEC Industries, Inc., and Minneapolis-Moline Co., Minneapolis; Louis B. C. Fong, Chief, Industrial Applications, NASA, who will serve as Executive Secretary of the committee. Both Godsey and Buryan serve as special consultants to the Administration.

New Fuel Cell for Space

The Air Force has contracted with Westinghouse Research Laboratories for development of a unique solid-state fuel cell for generating electric power in space. Such a fuel cell requires no pastes or liquid chemicals to produce its chemical electricity.

The contract, with the Air Force Aeronautical Systems Division, Wright-Patterson AFB, Ohio, calls for modification of the cell to determine its technical feasibility for aerospace applications, and for evaluation of the cell in comparison with other space power systems. Performance will be established through construction and evaluation of test models suitable for a space environment.

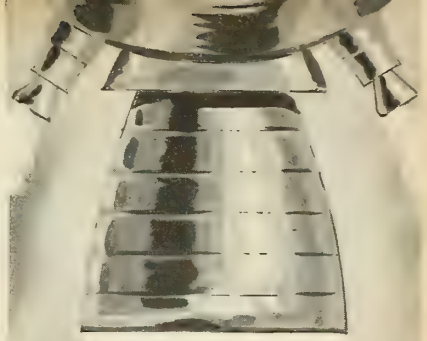
The solid-electrolyte fuel operates at about 1850°F. At such temperatures, certain inorganic, ceramic-type materials can be substituted for the electrolytes used in low-temperature cells.

Purpose of the electrolyte is to carry charged atoms (ions) between two electrodes—one positive, the other negative—producing an electric current.

The cell's fuel is hydrogen, methane or other gas, which flows through a chamber containing the negative electrode. Similarly, oxygen gas is fed continuously to the positive electrode. The electrodes are metals such as platinum and nickel, which are capable of resisting high temperatures and chemical attack by hot gases.

Laboratory versions of such solid-electrolyte fuel cells have exhibited current densities of more than 100 amperes per square foot, Westinghouse says.

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Awards in two months . . .

LLSV Study Bids Due Aug. 20

Thirty-one firms interested in spacecraft for which development cost may top $500 million

by Hal Taylor

THIRTY-ONE FIRMS have picked up proposals for bids on two study contracts for a Lunar Logistic Supply Vehicle which will probably be Project *Apollo's* next major spacecraft development program.

Bids on the two contracts are due on Aug. 20, with the contract expected to be awarded about six weeks later.

A NASA official estimates total cost of the study awards at about $200,000 each.

Actual development cost of the spacecraft has been estimated by a high NASA official at over $500 million; this accounts for the large number of interested firms (M/R, July 23, p. 15).

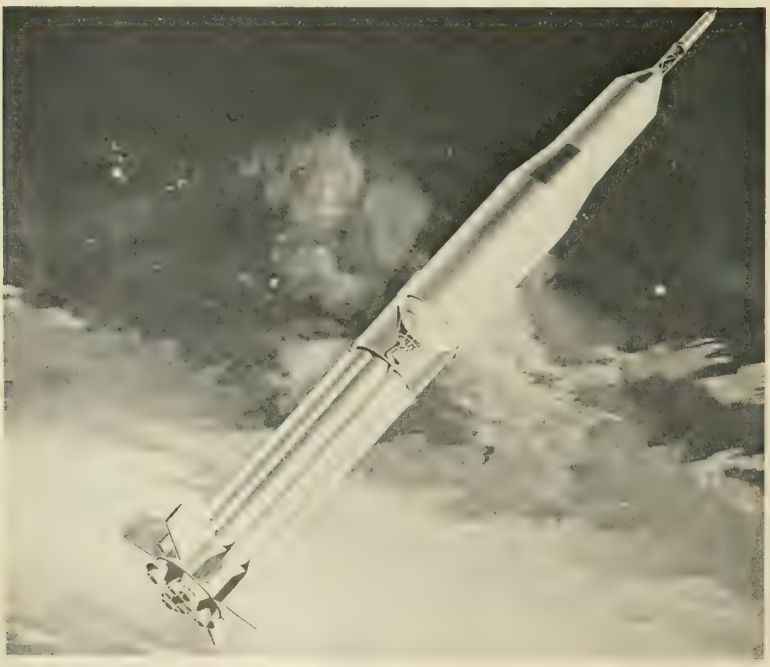
While the NASA announcement said no decision has been made as to whether the vehicle is necessary to Project *Apollo*, officials of NASA's Office of Manned Space Flight earlier told MISSILES AND ROCKETS that such a vehicle is required for any manned lunar landing.

Their current reticence is no doubt based both on the lack of a top-level decision affirming their position and on recent congressional action withholding approval of funds for the *Prospector* spacecraft. That spacecraft was to have performed the same sort of mission as the LLSV.

It is expected that development of the vehicle—when finally approved—will not begin until sometime in 1963. There is a good chance that it will have to wait approval of NASA's Fiscal '64 budget.

The 31 firms attended a bidders' conference held by the space agency on Aug. 8.

Proposals were requested from industry for two separate three-month studies—one of a spacecraft bus which could carry the support payloads to the moon and the other of a variety of payloads which could be soft-landed near the *Apollo* landing site both before and after *Apollo* manned missions.



ARTIST'S CONCEPT of Saturn C-1B. Douglas Aircraft just won a $141-million NASA contract for six S-IVB stages. S-IVB will be used on C-1B and Advanced Saturn.

• **Bus concept**—The first study will be of a spacecraft bus concept which could be adopted for initial use on the *Saturn C-1B*, and later use on *Saturn C-5* launch vehicles with a minimum of modification. Total weight of the bus is estimated at 1500 lbs. using the *C-1B*, and 20,000 lbs. with the *Advanced Saturn* booster.

• **Payloads**—The payload study will be limited to potential performance of seven specific payloads. The objectives of the study are to determine how man's stay on the lunar surface might be extended either on an emergency or planned basis, how to increase man's capability for scientific investigation of the Moon, and how to increase his mobility on the lunar surface.

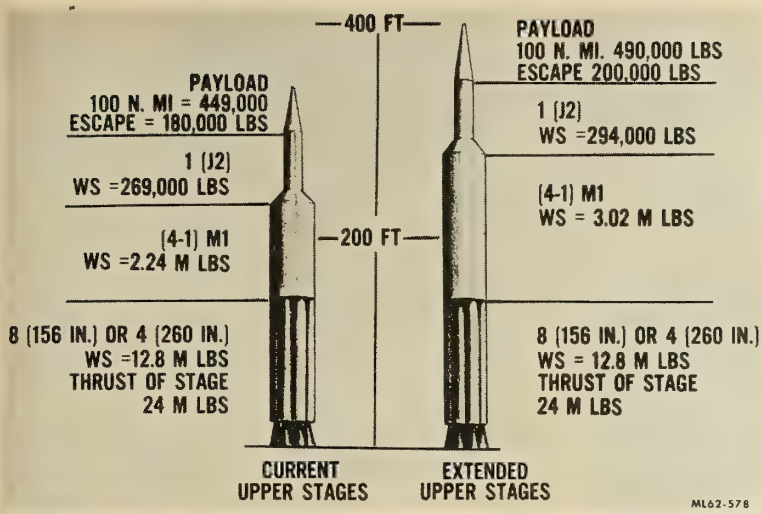
These logistics support payloads will be considered: Crew stay-time extension, crew shelter, proving vehicle, lunar surface modification equipment, power station equipment, communication station equipment, multiple-purpose payload.

Dr. Joseph Shea, Deputy Director (Systems) of NASA's manned space flight office, emphasized that *Apollo* manned missions are not dependent on the lunar logistics system.

"The in-house and contract studies are being undertaken to define a system which will improve man's capabilities on the lunar surface," Shea said, "but a final decision to develop a lunar logistics system has not been made."

• Firms picking proposals for both the bus and payload contracts included Avco, Lockheed, General Dynamics, Bendix Systems, Douglas, Northrop, STL, Grumman, RCA, McDonnell, North American, Martin, Raytheon, GE, Hughes, Ford Aeronutronic, Boeing, Electro-Mechanical Research, Litton, GPI and Librascope.

Three firms—United Aircraft Corp., Ling-Temco-Vought and Atlantic Research—picked up proposals for the bus only. In addition, seven firms collared just the payload proposals. These included General Motors, Westinghouse Electric, Melpar, (Westinghouse Air Brake), American Machine and Foundry, Goodyear Aircraft, Pratt & Whitney, and Republic Aircraft. ⠿



NEW NASA DRAWING shows "possible applications" of large solids.

Three-way compromise . . .

Solid 'Master Plan' Seen in 2-3 Months

Fight continues over which motors will be demonstration-fired; NASA restates arguments for early action

A "MASTER PLAN" for large solid motor development is off for two to three months—with indications that it will be a compromise between Air Force, Defense Department and NASA positions.

The timetable was set by Thomas F. Dixon, deputy NASA associate administrator, in testimony last week before a House Space Subcommittee.

Included in the plan, Dixon said, would be provision for engineering feasibility demonstration of both the proposed 156-in. and 260-in. solid motors.

Dr. L. L. Kavanau, special assistant for space in the office of the Director of Defense Research and Engineering, told MISSILES AND ROCKETS the plan would be out "soon." He declined to say what type of program would be approved by DOD "until a final decision is made."

A high Administration official told M/R it was likely that a program calling for the firing of a 156-in. motor had been approved, but no decision has yet been made on the 260-in. motor.

He said a compromise on the 260-in. might involve building and firing a motor only one-half its proposed height of 113 ft.

This was discounted by Kavanau, who said no decision on the 156-in. motor has been approved by DOD.

• **More hassling**—The statements of all three officials made it clear that ahead lies the same disagreement and delay which have plagued large solid-propulsion development in the past.

The Air Force and NASA about two months ago prepared a development plan which called for demonstration firings of motors in both the 156-in. and 260-in. categories. This was rejected by DOD, which told both agencies to go back and review the plan.

NASA continues to hold out for demonstration firings of both motors as long as DOD funds the program. DOD, however, does not want to approve funds to develop a booster for which no mission has yet been approved. In addition, it is leery of providing funds for the 260-in. motor because new facilities would be required. There is no certainty, the Pentagon believes, that enough motors would be built to justify the cost of the facilities.

Dr. Harold Brown, director of DOD research and engineering, previously told Congress that the large solid boosters which have been proposed "are not very attractive" and that he is in favor of limiting efforts beyond the 120-in. motor of the *Titan III* merely to developing necessary supporting technology.

The Air Force, given the solid propulsion development program, would like to move ahead with development of actual boosters. Besides its troubles with DOD, however, it is hindered by the fact that NASA has never given it a requirement that the big boosters must be developed for the U.S. space program.

• **NASA's reasons why**—Instead, NASA has said that it would like the large motors fired so that it can decide some time in the future whether liquid or solid propulsion is more feasibile for its *Nova* launch vehicle.

This position was restated by both Dixon and William Cohen, the space agency's solid propulsion chief, during last week's hearing.

Cohen said that the firings were necessary to gather information on key areas in solid motor technology. The areas include, he said:

—Establishment of insulation systems for the interior of the motor.

—Establishment of mechanical joint designs and insulation of joint regions.

—Establishment of nozzle structures and materials for long burning time.

—Demonstration of methods for processing very large propellent charges.

— Development and demonstration of thrust vector control systems for long burn time motors.

—Development of handling and transport methods for motors of very large size and weight.

He said that NASA is presently trying to get some of the answers in these areas through both in-house and industrial studies.

The NASA in-house activities, Cohen said, are now under way at Marshall Space Flight Center to analyze the many aspects of the design and handling of the vehicles.

Marshall will first specify in detail the burning time and thrust characteristics of the solid-propellant motors to meet the limitations of the liquid motors and stages, the manned payload, and the guidance system. This is necessary because the solid booster must not produce excessive acceleration loads on the men in the capsule.

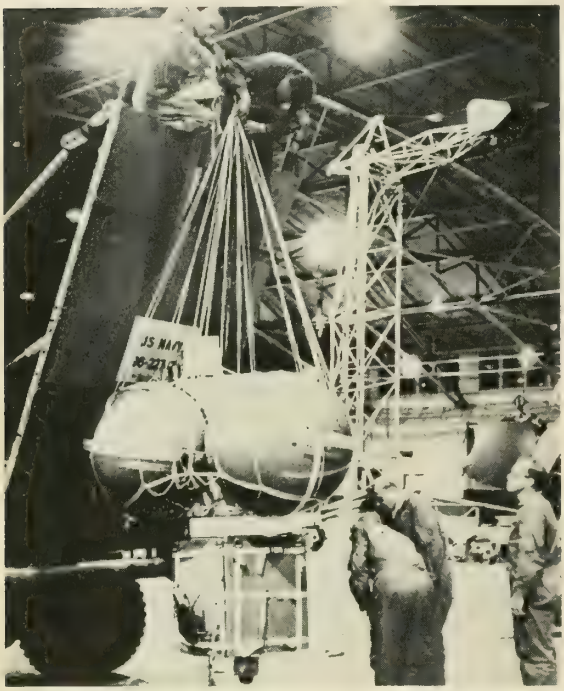
He also said NASA has established a number of contracts with private industry to work out the details of stage design, interstate design, and handling, transport, and launch problems. The Boeing Co. at Seattle, under Contract

(Continued on page 51)

No funding allowed . . .

AF Knocked Out of Primate Program

But NASA may decide to pick up tab for entire project using recoverable capsules; monkeys survive balloon launch



INSTRUMENTATION box and spheres are attached to balloon prior to Aug. 1 launch of monkeys and other organisms.

THE PENTAGON has killed another Air Force attempt to increase its military space mission by refusing to approve funds for a joint NASA-Air Force bioastronautics program.

The project, may however, be rescued by the space agency, which is currently studying the possibility of funding it by itself.

The Pentagon decision held that while Air Force personnel and facilities could be made available for the program, the service could not participate in its financing.

The action came shortly after top NASA and Air Force officials had approved the program calling for six launches of primates in recoverable capsules. Under the plan, the Air Force would have provided $31 million and NASA about $45 million for the program.

Proposed launch vehicle was the *Atlas-Agena*. The recoverable capsule would have had a two-week orbital capability.

While the Pentagon decision has not killed the program completely, it has certainly delayed it for some time. Even if NASA decides to provide all of the funding, it is likely that both the scope and cost of the project will be reduced.

The current NASA study is aimed at the possibility of using already developed capsules. One official indicated that this includes the *Mercury* capsule, which has already chalked up two successful manned space flights.

The space agency would still like to make two-week-duration flights. One phase of the plan would involve low circular-orbit flights below the radiation belts. Later flights would have eccentric orbits which would take the capsule out to the Van Allen radiation belts.

Concerning the current review, the NASA official indicated that a final decision would have to be made before the agency's Fiscal '64 budget is finalized. This will be sent to the Budget Bureau for approval early this fall.

• **Problems**—There are, however, some serious roadblocks in the way of the program, including:

—The *Atlas-Agena* pad at Cape Canaveral can only be used about eight times a year. For the next two years, it will be tied up with launches in NASA's unmanned lunar and interplanetary flight programs. It is possible this could be circumvented by simply using an *Atlas* booster.

—The space agency wants the program to provide bioastronautic information before it attempts long-duration manned flights. Those flights will begin in 1964 with the *Gemini* program. Thus, there are only about 18 months left for the primate program to be approved, developed and accomplished.

• **Monkeys recovered**—While the capsule program was in abeyance, the space agency moved forward in another area of its research into the effects on long space flights on astronauts.

The space agency announced that two monkeys had been successfully recovered after a 54-hour flight in a balloon to an altitude of 130,500 ft. Two hamsters—also included in the experiment—died shortly after the landing.

The launching at Goosebay, Labrador, on Aug. 1 was the second of four designed to provide information on the biological effect of heavy cosmic radiation on man.

Scientists at NASA's Ames Research Center said it would be almost a year before detailed results of the flight will be available. This is the length of time needed to cut the brains of the monkeys into 15,000 separate slices for microscopic study.

The brain of one of the monkeys was fixed for sectioning 48 hours after exposure. The other monkey was kept alive pending the possibility of getting more monkeys exposed this year in order to get a series of brains with different times after exposure.

• **50-60 hours goal**—Whole aim of the project—payloads of which include many other biological specimens in addition to monkeys and hamsters—is to find out biological effect of heavy cosmic primaries on man, Dr. G. Dale Smith of Ames told M/R.

"We are looking now to make sure that the heavy cosmic primaries are not going to be detrimental to man. We don't know for sure if a man is put up for 64 hours or 14 days that the heavy cosmic primaries would not have any detrimental effect on his performance.

(Continued on page 52)

80% new missile . . .

Polaris A3 Firing Tests Under Way

THE CRUCIAL *Polaris* missile system—a key factor in the U.S. nuclear arsenal—is moving into a phase which will vastly increase its deterrent power within two years.

The 2500-mile *A3* version of the Navy's submarine-launched weapon, with 1000 miles greater range than its immediate predecessor, the *A2*, was fired for the first time from Cape Canaveral Aug. 7. After a successful takeoff and near-perfect flight through first stage, the missile malfunctioned shortly after second-stage ignition and fell short of the 1995-mi. limited trip planned for its maiden flight.

Navy officials called the launching a partial success. They began studying telemetry data to pinpoint the cause of second-stage failure.

• **Four-fifths new**—The configuration of the *A3* is a drastic departure from the earlier models of *Polaris* (see cover photo).

The familiar bottle shape has been replaced by a blunt, bullet-like form. The basic "envelope"—31½ ft. long and 54 in. in diameter—remains the same, however.

Much more than the appearance of the Fleet Ballistic Missile has been altered. As previously reported (M/R, July 9, p. 17) the *A3* is, in the words of Lockheed Missiles and Space Co. officials, "an 80% new bird."

The *A3's* guidance package is only one-third the size of that employed in the 1500-mile-range *A2*.

The steel motor casing of the *A2's* Aerojet-General first stage has been replaced by a filament-wound fiberglass case, also by Aerojet. The company calls it the largest and strongest glass motor case ever flown.

The second-stage case, produced by Hercules Powder Co., is also fiberglass —as it was in the *A2*.

A major alteration is the replacement of the jetevators used to control the first stage in the *A1* and *A2* by a system of rotating nozzles. The latter method was used to control the second stage of *A2 Polaris*.

At a briefing prior to the Aug. 7 launching, Navy spokesmen said the second stage of *A3* will be controlled by fluid injection into the nozzle. The flame is deflected by introducing small amounts of the liquid, causing a change in direction of thrust.

Spokesmen declined to say what liquid is used or whether it is combustible. It is known that during earlier tests, freon, nitrogen tetroxide, and bleed-off from the combustion gases were used.

• **The schedule**—*Polaris A3* is due to be operational by the middle of 1964, a briefing officer said. "Operational," for *Polaris*, means it will be in full production and on station with submarines at sea. In the case of *A3*, this will mean subs able to strike far deeper into the Soviet heartland should the need arise. In fact, the missile will be capable of hitting any target on Earth.

For the present, the spokesman noted that the FBM sub USS Ethan Allen is now on patrol carrying *A2 Polarises*.

He added that *Polaris* subs have all 16 of their missiles ready to fire 95% of the time, 15 ready 99.9% of the time, and 14 ready all of the time.

• **Production**—Lockheed plans to set up a pilot line for *A3* production early in 1963, by which time the design is expected to be 98% frozen.

Delivery of the first *A3's* will come about a year later.

Stanley W. Burriss, vice president and general manager of LMSC's Missiles System Division, noted that the *A3* program will not permit the leeway or tolerances which were found to be acceptable in the development and manufacture of the *A1* and *A2*.

• **False starts**—There were two unsuccessful attempts to get the *A3* off during the week preceding the Aug. 7 shot.

The countdown reached T minus 75 minutes before a shot was scrubbed on July 31. A second attempt, on Aug. 2, was cancelled at T minus 8 minutes. ⁘

A 'First' For Sparrow III

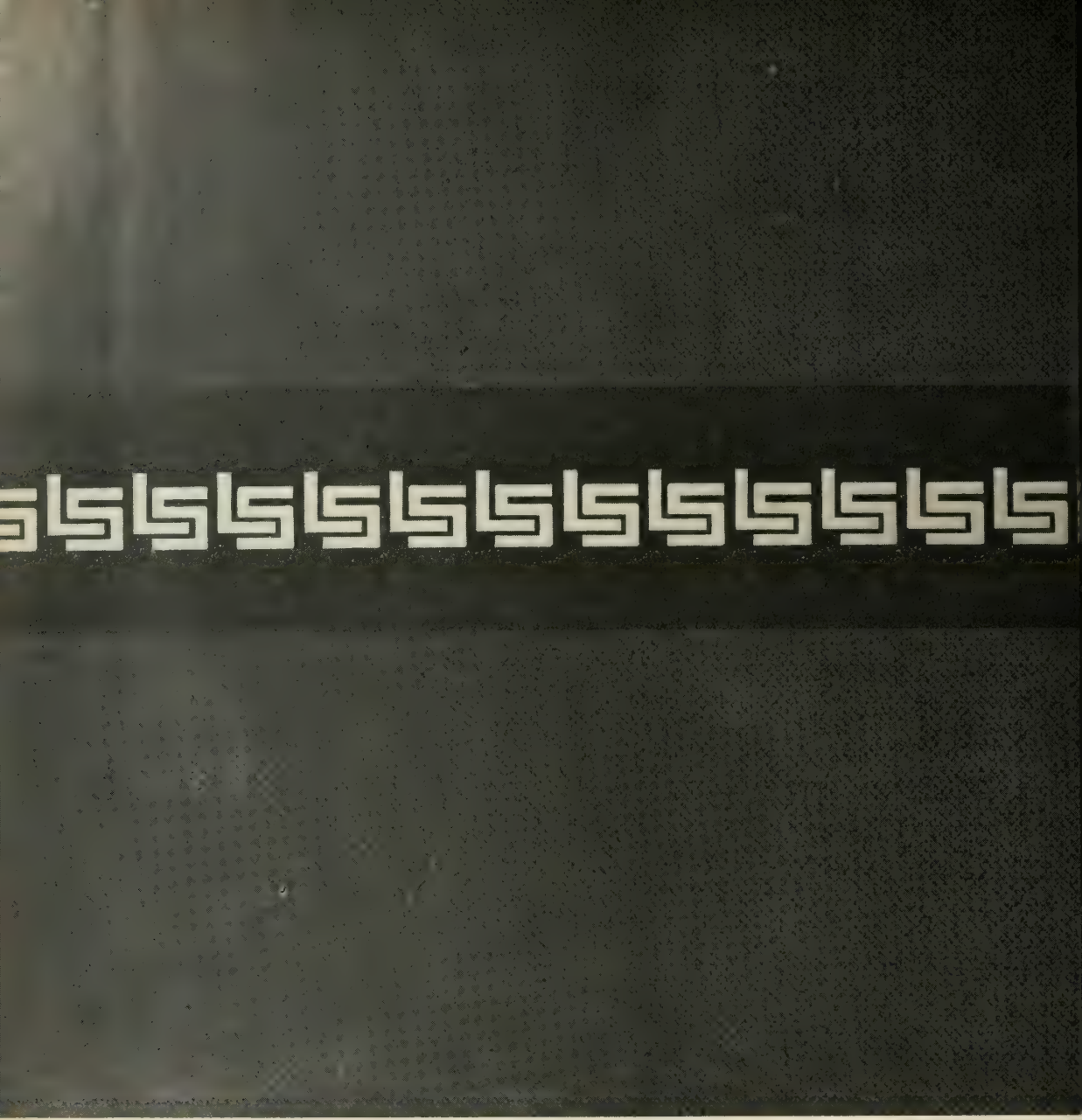
THE FIRST "direct head-on hit" of a surface-launched missile by an air-launched missile was reported by the Navy last week.

The supersonic intercept took place over the Pacific Ocean when a Raytheon *Sparrow III* destroyed a *Regulus* target. Significance of the kill is that it was a head-on strike, demonstrating the capability of the *Sparrow's* semi-active cw homing system to intercept a target in the forward hemisphere and at high closing speeds.

The *Sparrow* was fired from an F4H Phantom II fighter, which can carry six of the missiles. *Regulus*, a Navy missile that never became operational, is being used as a supersonic target.



CORRECTION: *Sparrow III is shown here hung on a wing pylon of the F4H Phantom fighter. In the July 30 Sixth Annual Missile/Space Encyclopedia, M/R inadvertently identified a Sparrow I as Sparrow III, which scored a significant intercept last week.*



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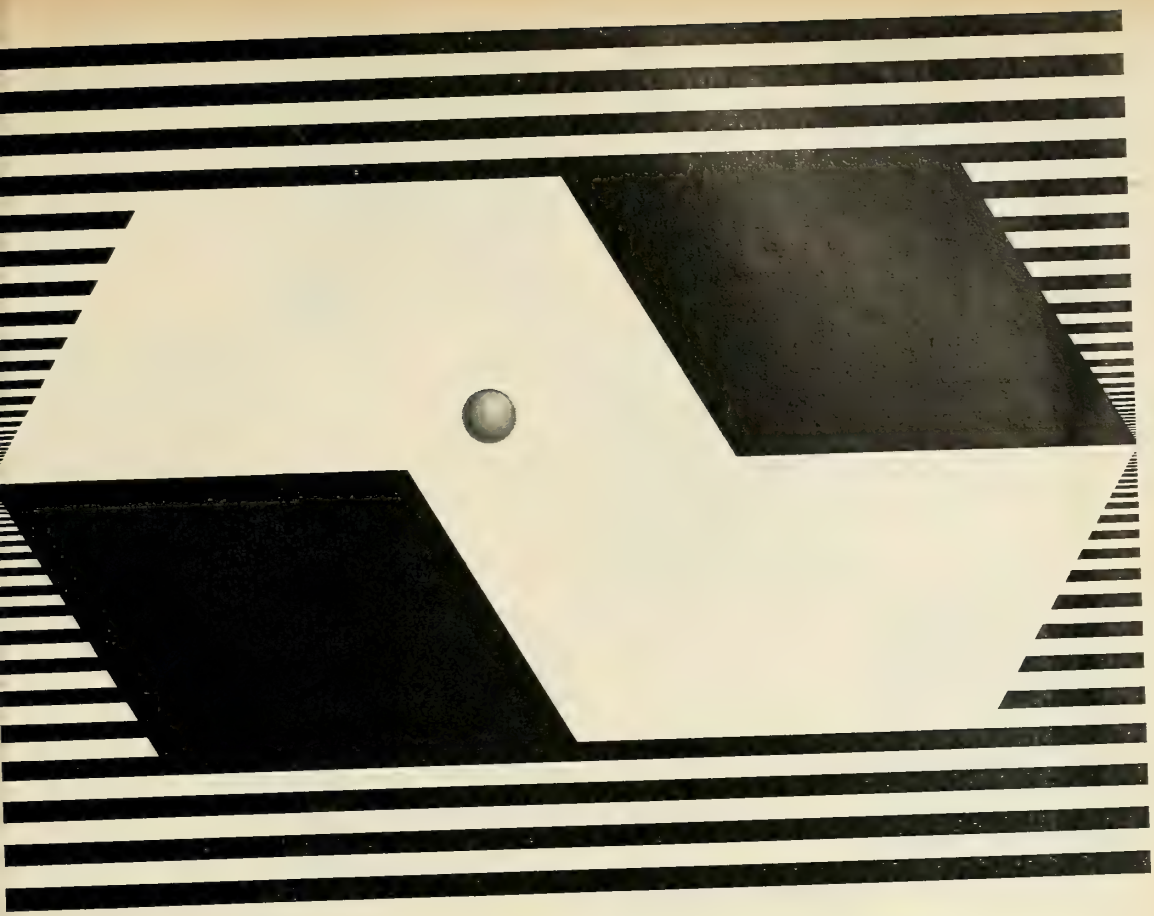
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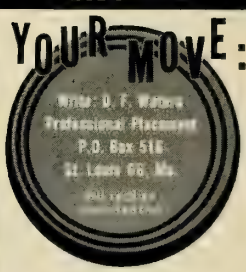
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Technical Countdown

ELECTRONICS

MMRBM Guidance Breakdown

Although reported as somewhat higher, the actual *MMRBM* stellar-guidance contract award from the Air Force to General Precision's Aerospace Division as of this date is quoted by insiders at $185-190 million. This includes initial production but does not reflect funding expected ultimately from the Navy. Nortronics Division of Northrop is currently negotiating a subcontract to supply the two-star tracker subsystem. Arma Division of American Bosch Arma will supply its highly advanced guidance digital computer, a 9 x 9 x 10 in. solid-state system. The present contract calls for a total development period of just over four years. It's reported that GPI also will develop concurrently a back-up all-inertial guidance system for the missile.

Pencil Triode Lasts 25,000 Hours

A ceramic-metal pencil tube triode, expected to have an operating life in excess of 25,000 hours, has been developed by RCA. The tube is the result of a two-year contract with the Army Signal Corps directed toward development of a long-life pencil-tube triode, which can be used as a frequency tripler in two frequency ranges—111 to 333 mc and 333 to 1000 mc. Life tests have now progressed beyond the 8000-hour mark with no changes in tube characteristics. RCA credits the extensive reliability of the tube to special fabrication techniques and ultra-clean assembly areas.

Bell Perfects Maser Amplifier

A "traveling wave" pulsed ruby optical maser, which can amplify or intensify light directly, has been constructed at the Bell Telephone Labs. The techniques employed are similar to those involved in microwave maser amplifiers. The device is composed of two maser amplifying sections with an "isolator" between them. The active maser material is ruby and the active isolator material is lead-oxide glass. The amplifier has a bandwidth of 100 kmc and a net gain of 13 db—an amplification of 20 times.

Booster Research Cost Computerized

Cost estimates covering rocket booster research are being accomplished with computers at the Boeing Co. A computer program known as WESCOM (Weapons System Cost Model) finishes in 20 minutes what one cost estimator armed with a desk calculator can do in 5.5 hours. Boeing specialists say the program has enabled the cost-estimating staff to turn out three times as much work with only a small increase in personnel.

ADVANCED MATERIALS

Sprayable 5000° Insulation Marketed

A sprayable, modified resorcinol-phenolic complex, capable of halving the cost of insulating nozzles and propellant chambers with an application time of six hours, has reached the marketing stage at Nobell Research Labs. During applications, the liquid and powdered portions of the formulation combine instantly in air to form a rubber-like material that bonds tightly to the sprayed surface. A coating only 0.25 in. thick will transmit about 30 degrees in one minute from a 5000°F flame. Panels 0.3 in. thick withstood the same flame for 4 minutes before burn through.

Honeycombed Solid Grains

The use of honeycomb materials as internal structures for large solid rocket grains has been demonstrated in small-scale tests at Stanford Research Institute. The concept would involve a combustible honeycomb material to be used for grain reinforcement as well as to isolate reactive substances from each other until the honeycomb wall is consumed. SRI has also tested the method with chemically incompatible ingredients. Isolating a liquid in the honeycomb and adding a gelling agent results in behavior similar to that of a solid. The project is supported by Hexcel Products, Inc., under an ARPA contract.

New High-Temperature Measuring Method

Temperatures above 5000°F may be measured through a method developed by Dr. W. H. Giedt of Advanced Technologies Labs under an Air Force Aeronautical Lab contract. The process involves immersing two thermal elements having identical dimensions but unequal thermal capacities for a very short time, then withdrawing them and recording their temperatures. Initial concern in the development is selection of the proper ratio of heat capacities, geometries and types of sensors to be used. Investigations now in progress will determine the limitations of the technique with respect to proposed uses in high-temperature work.

Ballistic Research Awarded to ARC

Atlantic Research Corp. has initiated work on an Air Force ballistic research program. Special solid-propellant test vehicles will be used to obtain information aimed at enhancing ballistic missile effectiveness at much lower cost than if actual weapons were used. Tests will be conducted at the White Sands Missile Range, with launches made from the vicinity of Blanding, Utah. The ARC phase of the program will cost about $17 million.

Edwards AFB Test Facility Near Operational

The world's largest combined environmental test facility is nearing completion at Edwards AFB. Destined to be operated by Space Systems' 65930 Test Group (Dev.), the complex has a 30g centrifuge and can assume any combination of acceleration, vibration, temperature, humidity and altitude. Designed temperature range will be between −300° and 500°F, and vacuum conditions of near space will be possible. The installation was designed and manufactured by the Rucker Co.

GROUP SUPPORT

All National Ranges May Be Standardized

As a result of the recent National Missile Range Calibration Conference at Point Mugu, Calif., the precision measurements applied by the three national ranges may be standardized to use the same primary referrant and measurement procedures. In addition, a free interchange of technical information concerning methods, techniques, procedures, precision measurement and test instrument calibration requirements may be accomplished. Cross-comparisons of accuracies and methods among the ranges through audit measurement packages is also part of the tentative plan.

Goodyear Shows New Inflatable Station

NASA and military needs still undefined in this area; some observers believe decision may come in about a year

by Michael Getler

CLEVELAND—A 30-ft.-diameter prototype of what Goodyear Aircraft Corp. officials hope will eventually expand into a funded program for an operational 150-ft. inflatable manned space station went on display last week at NASA's Lewis Research Center here.

The new structure, which closely resembles an inflated inner tube complete with hub and a single large spoke, is the result of a two-year development effort undertaken by the firm at a cost of "several hundred thousand dollars."

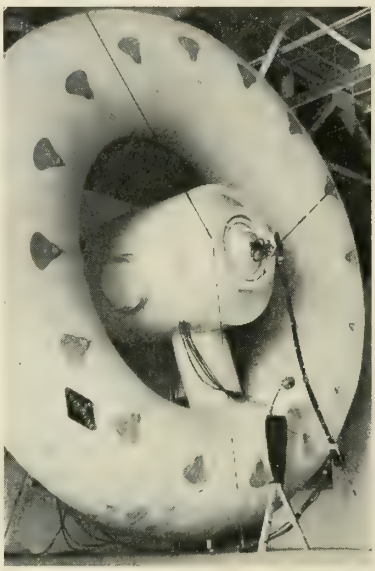
The station weighs about 1800 lbs. fully equipped, can support a crew of three, and is designed for orbital operations at altitudes between 200 and 500 miles. The walls of the torus are made up of three layers—a thin neoprene-coated Dacron on the outside, a two-in.-thick foam rubber center, and a reinforced filament-wound Dacron interior.

Though the torus has a 7-ft. cross-section when fully inflated, Goodyear officials report the huge outer ring collapses and folds into a 40-cu.-ft. package, which is in turn packaged around the hub during launching.

• **Hub's function**—The metal hub section, designed to serve as a spacecraft docking area and entry/exit port for the crew in addition to housing the stored oxygen and nitrogen inflation and life support tanks, represents half the station's weight. The hub is 12 ft. long and 8 ft. wide. Connecting the torus and hub is a single 3-ft.-wide, 4-ft.-long passageway.

GAC President Thomas A. Knowles told MISSILES AND ROCKETS that an unmanned 30-ft. experimental version of this station could probably be placed into orbit within a year using existing boosters. Knowles would like to see a launch similar to the recent *Echo* balloon test, in which data could be gathered quickly on packaging, inflation, and spin-induced gravity techniques, in addition to information on radiation effects and resistance of the station's skin to micrometeoroid bombardment.

GAC tests of various rubberized



ENGINEER checks station before display.

fabric combinations to protect against micrometeoroid punctures were made by firing pyrex pellets at the material at speeds of 16,000 to 20,000 fps. Engineers report the fabrics stood up well, but it should be pointed out that micrometeroid speeds in space are actually several times this fast.

Knowles went on to say that a 150-ft. version of this station, weighing about 16,000 lbs. and designed to hold a crew of 20-25 depending upon the mission, could be lofted into orbit by 1965 with availability of the *Titan III* or two-stage *Saturn* boosters. The torus in this configuration, they report, could be packaged in about 200 cu. ft. plus the hub.

• **Decision in a year, maybe**—GAC, like several other firms which are developing both techniques and actual hardware for future space station projects, is awaiting announcement of a formal space agency program in this area. Most of the NASA effort to date has been in-house with the exception of a $100,000 feasibility study award to North American Aviation (M/R, May 7, p. 14).

Some observers—noting the steadily increasing interest in large-scale space platforms for a host of scientific, logistics, and perhaps military missions—feel the decision may come this year. However, a highly-placed NASA official told MISSILES AND ROCKETS that "we are now in only a very preliminary discussion stage. At some point in time we will have one," he said, "but we are certainly at least a year away from committing ourselves.

"At that time," he continued, "it is likely that even more study work will be necessary, perhaps performed by two or three firms, in the light of more clearly defined mission requirements." He also indicated "there is no need for one to support the *Apollo* mission."

• **Advantages over metal** — GAC maintains that using a rubberized inflatable torus would yield considerable advantages in weight, reliability, packaging, and pre-flight testing over metal structures of similar weight, with no corresponding loss in puncture resistance.

By applying small jets to rotate the torus in orbit at about 4 rpm for the 150-ft. version prior to manning, engineers say they can maintain a 1-g gravity effect. The hub section would be kept at zero-g for docking operations and scientific experiments requiring the zero-g condition.

GAC has also designed inflatable furniture into the station that is compatable with the overall packaging and inflation scheme. The combination bunks and tables are made of two-ply fabric linked by nylon cords.

The 30-ft. version of Goodyear's space station now at Lewis is actually a growth version of a 24-ft. model supplied by the firm to NASA's Langley Research Center late last year (M/R, Jan. 1, p. 11). Scientists there are using the device to research problems encountered in folding and packaging, and are also studying leakage characteristics of the fabric. ⁂

Sounding Rockets for Only $8 a Shot

TEI's cold-propellant system also has potential for guerrilla warfare

by William Beller

A NEWLY DEVELOPED rocket will take aerial photographs, telemeter data for weather profiles to 3200-ft. altitude, or gather atmospheric information useful for scientific studies—for only about eight dollars a flight.

A few changes in the system will yield a lightweight guerrilla-warfare weapon that will carry a payload of several pounds down a 2000-yard range with no flash or fire and virtually no smoke or noise.

This is a cold-propellant rocket. It gets its impulse by expelling highly pressurized gas rather than products of combustion.

Because the rocket is used for relatively low-altitude and low-range work and carries only small payloads, the vehicle does not need the chemical energy released in combustion. Moreover, because the gases in a cold-propellant system are usually inert, they can be stored indefinitely and pose no safety hazard. The rocket can be so simply built that its reliability seems assured.

The data-acquisition version is called *Cricket;* the weapon, *Bellona.* Conceived and developed by Texaco Experiment Inc. (TEI) of Richmond, Va., the cold-propellant rocket is being evaluated by the U.S. Navy to provide data for fire control. The U.S. Army is considering it for mapping and weaponry assignments. It also is expected to be used operationally in certain areas to aid in local weather forecasting.

• **How it works**—The *Cricket* is only 40 in. long and 2.5 in. in diameter; its tail, comprising four folding fins, has an open span of 8 in. The rocket reaches an altitude of more than 3200 ft. with a ¾-lb. weather sonde—then is lowered to Earth by an automatically deployed parachute.

The *Cricket's* total launch weight is 5.5 lbs.: three pounds for propellants—acetone and dissolved carbon dioxide—and the remainder for structure, parachute recovery system and instrument package.

TEI engineers found that the CO_2-acetone combination gives the best results. Acetone absorbs and releases CO_2 at a good rate, yielding a total impulse of 60 lb.-sec.

After acetone is poured through the *Cricket's* nozzle into a storage chamber, the nozzle opening is plugged with a valve; liquid CO_2 is then forced into the chamber until the pressure rises to 800 psi and the valve is closed.

For launching, the rocket is placed in a short tube. A 10-ft. extension is added to guide the rocket until it reaches flight speed. A hand lever releases the rocket. It is impelled during its travel through the tube by a separate charge of CO_2 fed prior to launch into the volume beneath the rocket to conserve the vehicle's propellants.

As the *Cricket* emerges from the tube, the valve-plug blows out of the nozzle, the tail quickly unfolds, and the rocket soars upward under its own power. After the peak of its trajectory is reached, a mechanical timer deploys the recovery system.

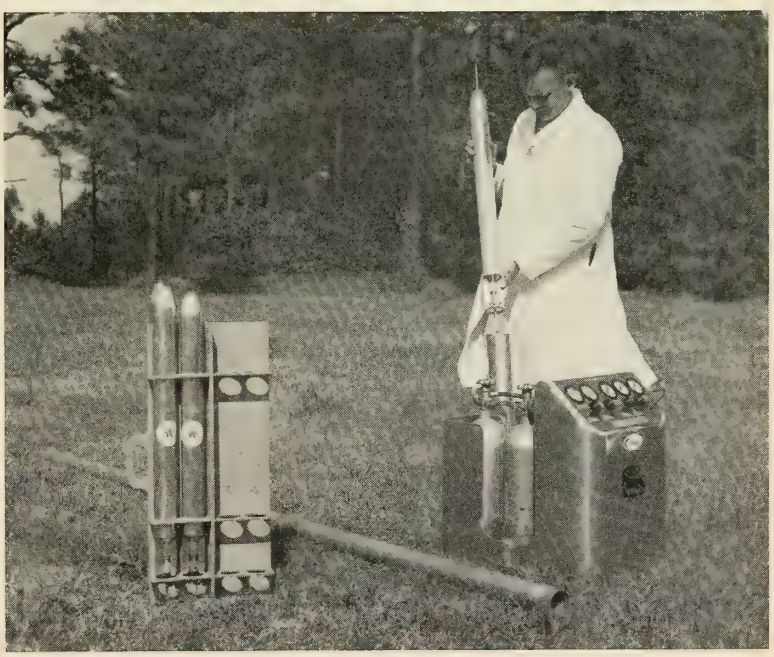
• **Has many uses**—When used for meteorological work, the *"Cricketsonde"* telemeters to a ground station an essentially continuous record of atmospheric pressure, temperature and humidity while a five-foot diameter parachute lowers the rocket vehicle at 600 fpm.

The weather-sonde package, made by the Friez Instrument Div. of Bendix Corp., transmits on 403 Mc; Jerry Burke, Jr., TEI vice president, told MISSILES AND ROCKETS that a 1680-Mc transmitter may soon be used to permit radio theodolite tracking for wind studies.

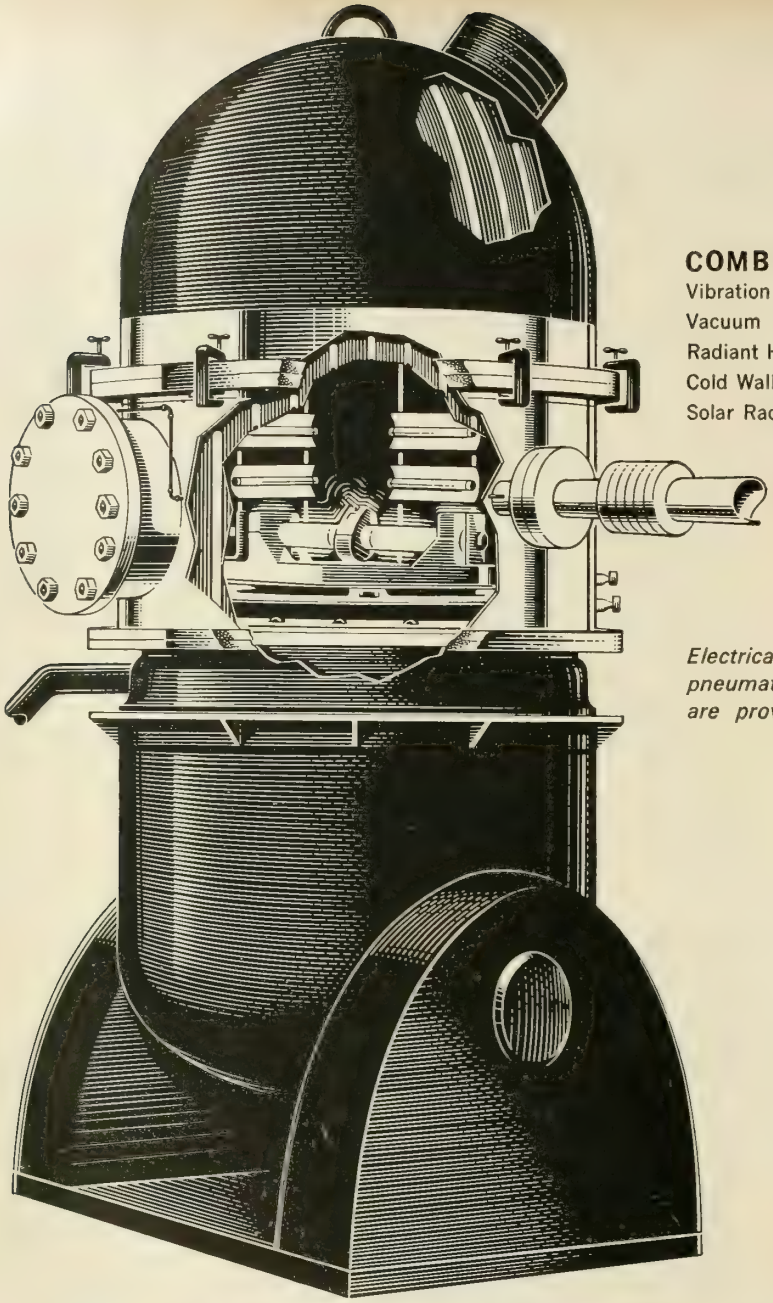
Cricketsonde bought in quantities will cost less than $100, according to TEI sales director Albert Yates: rocket shell and recovery system, about $35; payload package, from $40 to $50. Since TEI experience shows that each *Cricketsonde* is recovered about 10 times, the cost per shot will probably be close to $8.00.

Cricket can carry aloft nearly any one-pound payload. Thus, the rocket can be used for projects such as seeding local clouds for weather control, dispersing chaff and smoke for wind determinations, and gathering specimens of smog or radioactive materials for scientific studies.

A developing use is in aerial photography. TEI is devising a gyro-stabilized rocket vehicle to aim a nose-installed camera, which would take pictures on Polaroid film. When the system is perfected, it will probably have wide commercial and military uses. ⁂



TECHNICIAN LOADS Cricket weather sonde into launcher.



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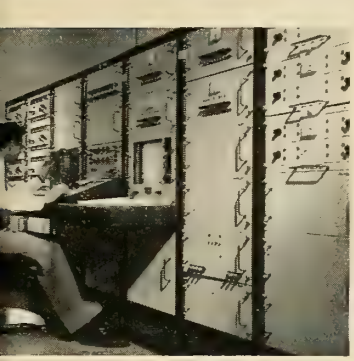
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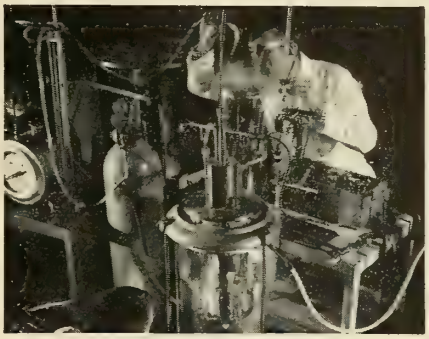
Making this possible is the unusual physical environment Beech has created at its modern aerospace center at Boulder, Colorado, and its extensive production facilities at Wichita, Kansas. Both of these facilities are staffed with expert, seasoned personnel who have long worked together on aerospace problems.

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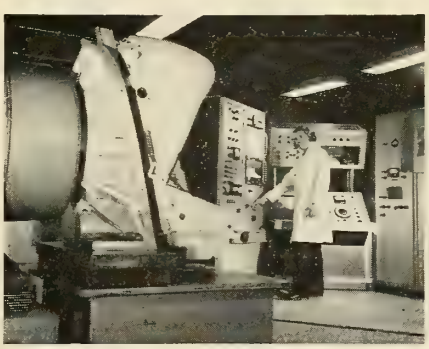
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'Fairplan' Aids Fairchild Comeback

By combining PERT techniques with spending forecasts, firm keeps close check on capabilities

by Charles D. LaFond

A NEW MANAGEMENT tool developed and now in broad use by Fairchild Stratos is contributing heavily to the company's financial recovery.

Called Fairplan, it employs standard PERT procedures coupled with a tight dollar/hour expenditure forecasting technique. As a result, Fairchild officials claim, the approach forces adequate planning of development and production activities and provides a continuous picture to management of resources and expenditures.

Further, Fairchild believes it serves as a good indicator of project performance by employing in-process check points.

The company reports that over the last 18 months Fairplan has successfully provided management with the decision-making data needed for effective control of its various R&D and production programs.

Fairchild financial figures tend to support this argument: net earnings of $3.1 million in 1961 show a marked increase over a reported $5.9 million net loss for 1960; first quarter earnings for 1962 are expected to approach $800 thousand; net earnings for 1962 conservatively are expected to top $3.2 million.

• **A classical approach**—The reorganization of Fairchild Stratos which began last year (M/R, June 26, 1961) marked its first anniversary last March. At that time the new corporate management team announced it would reshape the company into a space-oriented organization.

The new group is applying classical management concepts of planning and control to the task of developing the firm's missile and space capabilities. This is being done through Fairplan. Management feels the approach is adaptable to each of the firm's varied product lines, and that it is flexible enough to be applied to smaller development projects and subcontracts as well as large aircraft and missile programs. Its inherent simplicity, it is asserted, enables management to obtain data without being overburdened by laborious and detailed reports.

While Fairplan incorporates the latest known planning techniques, such as PERT/TIME and PERT/COST, it also takes cognizance of basic person-to-person contacts to determine status of potential problems. It is an ideal tool for decision makers, according to Tom Vincent, director of Fairchild Stratos' Corporate Programing Office.

Beginning last March, every project within Fairchild was placed under Fairplan control.

• **The Master Plan**—The complexity of a company that encompasses a very broad range of activities compels the manager to divorce himself from detail. Nevertheless Vincent believes, he must be provided with a tool capable of keeping himself and his program personnel aware of the broader aspects of goal and responsibility. This tool, Vincent asserts, must provide a faithful, up-to-date picture of the program at all times, following a uniform pattern understood by all.

Thus, a Master Plan serves as the tool for this purpose. It sets forth the broader definitions of responsibility for a proposed program or one already under contract. The business category of a program is defined as:

—*Firm* — for business presently under contract.

—*Carry-on*—for probable business to be added for which there is a requirement and firm planned fiscal funding or an effort on which the company is spending promotional money.

—*Potential*—for possible business to be added that does not fall into the category of either "firm" or "carry-on".

The Master Plan, in summary, is the guide and basis for determining manpower, facilities and financial requirements. It must be flexible, easily and quickly adjustable and must assure the immediate dissemination of information between manager and first-line supervisors under him, Vincent stressed.

The value of individual knowledge and information, while creating or adjusting a Master Plan, is an important ingredient. Consulting the engineering and marketing departments, and the program manager to obtain their respective inputs, is an absolute necessity. In the event of a conflict of information or other problem involving the Master Plan, the program manager's word is the final authority.

To best show the plan in use, Vincent drew up the accompanying typical Master Plan for an imaginary development program, the *"AN/USM-X"* missile system.

• **Supplemental plans**—Overall program planning networks and detailed schedules are required to supplement the Master Plan.

The tools of internal schedule control provide program personnel with the necessary data and direction enabling them to accomplish a task within allocated time. The ideal situation, said Vincent, would be to have all programs always on schedule; it must be recognized, however, that complex production, research and development and scientific studies cannot exclusively follow a detailed plan.

Vincent feels that the Fairplan technique applied to planning and scheduling is similar to that employed first on the *Polaris* program—the Program Evaluation and Review Technique (PERT). The extent of PERT application however, should be governed, Vincent maintained, by the complexity and size of the program under consideration. Computer programing, for instance, need not be applied to programs easily calculated on paper.

The basic plan must include an orderly array of events, shown in time sequence, leading to completion of a task. Before creating a plan or network, said Vincent, a group of technical planning personnel should be established to define the objectives of the specific program or project. In developing the detailed network, he has found this team approach is most effective.

Guided by the Division's Project Planning Department, the team may include representatives from tooling, factory, materials, engineering and contracts. Each member is capable of defining the steps in a plan which relate to his own departmental activities. The plan is drawn by the team with a disregard for time until all activities have been defined in orderly sequence between the starting and completion events of the program.

A PERT network serves as a graphic representation of time-flow and

the sequence of activities. By monitoring actual performance on individual activities, it is possible to determine very quickly the effect on delivery schedules.

By relating performance and output, the effects of reallocating program resources to maintain a schedule critical path can be assessed and appropriate action initiated.

On a detailed level, a page and line schedule is used to guide and monitor component equipment, or task completions. It serves as a project review vehicle for planning personnel to determine work status at any given time.

Other standard control charts may be employed to implement individual engineering development goals called for in the page and line schedule.

The evaluation and reporting to management of project status obtained in regular meetings of department representatives is performed through a Schedule Delinquency Report.

Implementation is critical, said Vincent, at the delinquency-report stage. Delinquencies or deviations from the project schedule must be taken seriously and corrective action initiated before a complete plan overrun takes place.

• **Dollar and hour resource control** —The close relationship between plan and cost, Vincent pointed out, is clearly demonstrated when a change in plan causes a cost change. To give the manager a quick look at this relationship, a program graphic evaluation system has been created, covering the areas of planned expenditures, completion, and, if applicable, funding versus "actuals" with a forecast.

This graphic evaluation may be presented in any extent of detail necessary for control. It is believed most effective when used to control major elements of cost. In this way detailed information is supplied automatically when unfavorable cost deviations occur.

A program graphic evaluation system in the form of input/output charts includes these major points:

—Planned funding (resources expressed in hours or dollars) allotted to accomplish the task defined for the *AN/USM-X* Missile Program.

—Planned completion date.

—Inception of planning date.

—Planned expenditures plus commitments (the time-phased rate at which resources are planned to be expended or committed).

—Planned completions (the time-phased-rate at which work elements are planned to be completed. Each work element or task has a preassigned dollar value.)

—Planned checkpoints (time-phased major milestones necessary to complete the *AN/USM-X* program).

• **Evaluation by exception**—If, on the evaluation date, each of the pairs of measurements are equal (Planned and Actual Funding, Planned and Actual Expenditures, Planned and Actual Completions, Planned and Actual Checkpoints), then the effectiveness factor is 100% and no further evaluation is necessary.

If there is an exception to any of the measurement pairs, two evaluations are necessary.

To determine the Effectiveness Factor, the actual completion is compared with the planned completion for the amount of resources expended.

Dollar and hour resource control are computed graphically by extending a horizontal line from actual expenditures (e) to Planned Expenditures (f), then by dropping a vertical line from (f) to Planned Completions (g). The calculated Effectiveness

$$\text{Factor} = \frac{\text{b-d}}{\text{g-d}} = \frac{10.4\text{-}5.0}{11.0\text{-}5.0} = 90\%.$$

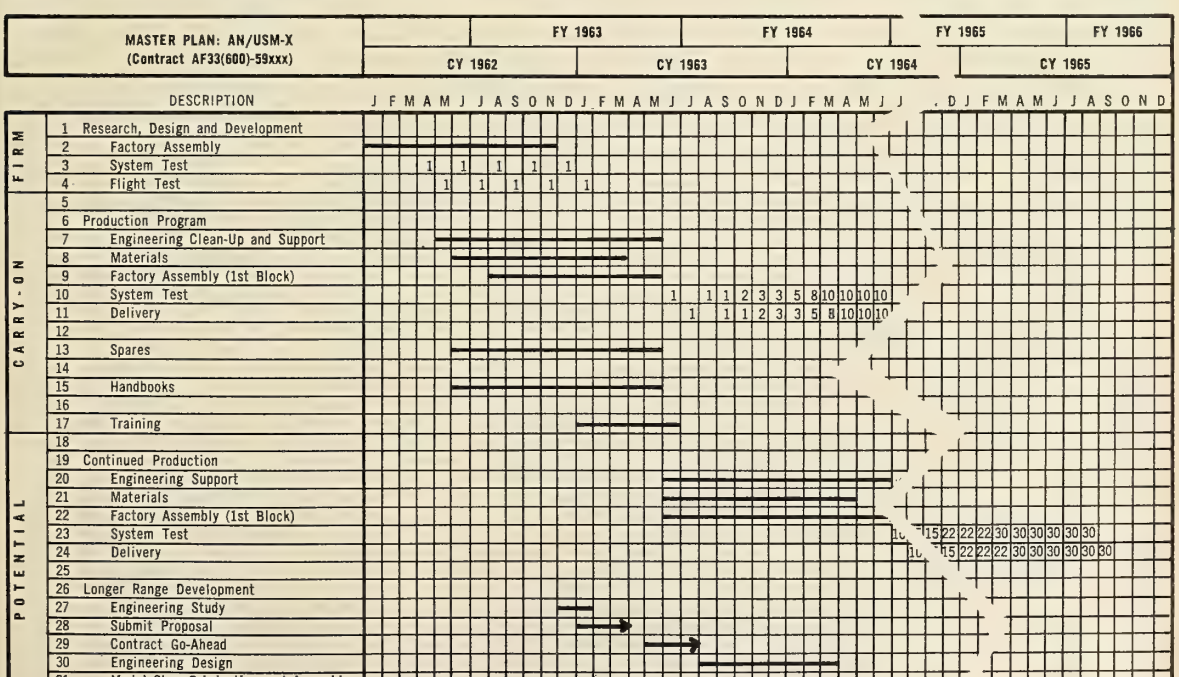
A 90% effectiveness is unsatisfactory, of course, because the goal in a sound plan is 100% effectiveness throughout. Both input and output are ahead of plan; however, when input is 18 (f), output should be 11 (g). Output is actually 10.4 (b).

To determine Actual Percent Complete while knowing that effectiveness is 90%, Vincent pointed out, it also is necessary to know what portion of the program has been affected by this unsatisfactory rate. Thus, actual Per-

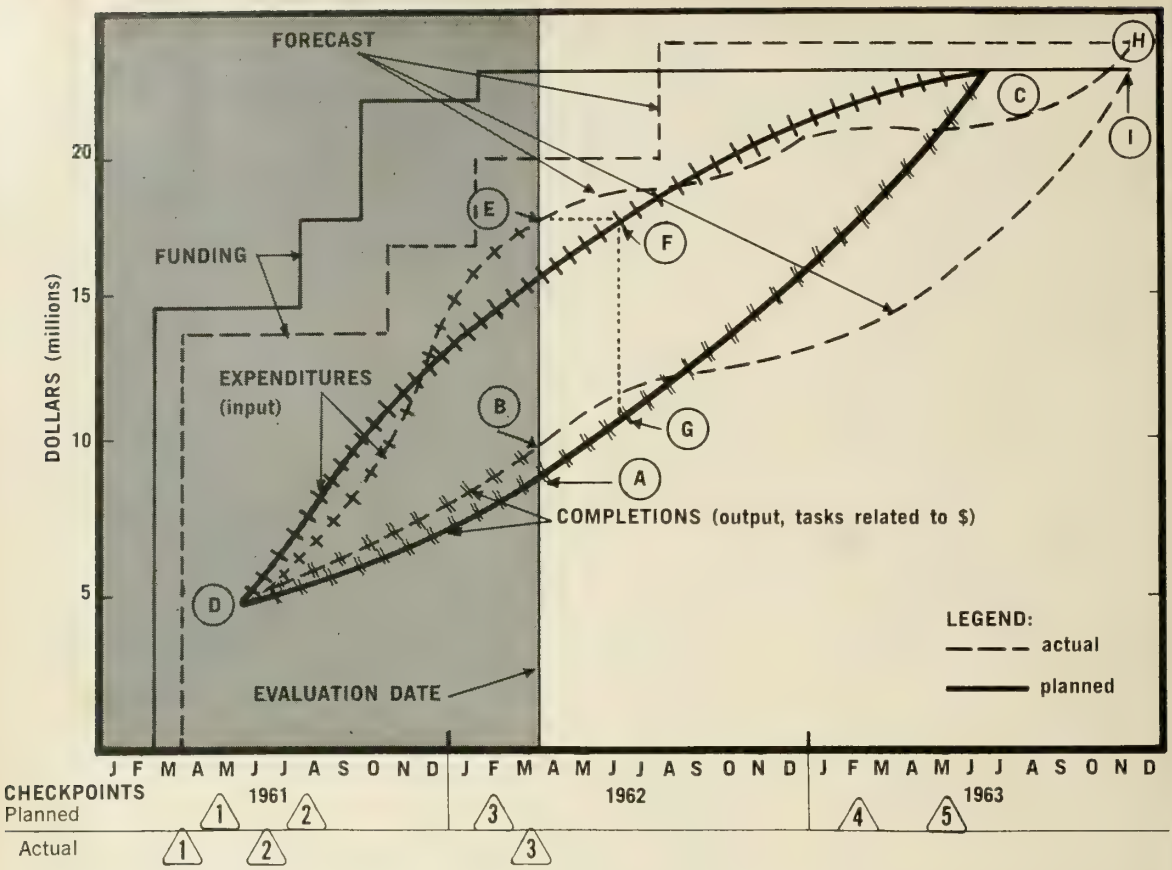
$$\text{cent Complete} = \frac{\text{b-d}}{\text{c-d}} = \frac{10.4\text{-}5.0}{23.0\text{-}5.0} = 30\%.$$

Since 30% of the program was completed at 90% effectiveness, a method of recovery forecast becomes necessary.

• **The recovery plan** — A forecast



TYPICAL MASTER PLAN (this one actually for an imaginary weapon system) in Fairplan approach.



HOW GRAPHIC EVALUATION SYSTEM is used to determine Effectiveness Factor (see text).

and recovery plan is constructed in the following manner. Evaluation by exception shows that the program is significantly off plan. The recovery plan is a matter of re-planning from the evaluation date through the end of the program at the best possible effectiveness rate during the time remaining.

For dollar and hour resources control, the following forecasts are needed:

—Forecasted funding

—Forecasted completion date (h and i)

—Forecasted expenditures (e to h)

—Forecasted completions (b to i).

In computing these forecasts, a new effectiveness rate had to be set for the remaining 70% of the program. For comparative purpose it may be computed as: Forecasted effectiveness

$$\text{factor} = \frac{\text{h-b}}{\text{i-g}} = \frac{24.0\text{-}10.4}{23.0\text{-}11.0} = 113\%.$$

• **Special applications** — There are special applications of Fairplan that may be utilized in isolated cases of a program that requires more than normal attention because of a peculiar or special situation.

To satisfy this need, Fairplan provides the tool for a "crash team." The team, guided by Project Planning, is comprised of representatives of all the departments involved. The team may meet as frequently as every day to discuss specific problems and to make assignments for resolution.

Crash teams may be organized to resolve any problematical situation within the course of an entire program. Such teams have been effective in resolving problems of a technical nature as well as procurement, assembly or test problems.

• **Change of plan control**—Fairplan incorporates a method for accommodating individual changes at various points in a program. These changes are initiated by a change board chaired by a representative from the Project Planning Department, staffed by one representative from each effected department and one from the department originating the change.

The change board has the authority to act on behalf of the program manager. No proposed changes are implemented by any department without prior approval of the change board.

The department originating and proposed change prepares in writing a complete justification for it which includes: Reasons for the change, effect on material, manufacturing and testing and the suggested release date of the change.

The board members decide whether to authorize a change and when it should be placed in effect if authorized. This decision is based on discussion at the board meeting. When there is non-agreement among the members, the decision may be made by the chairman. His decision may be appealed to the program manager by any of the non-agreeing members.

Proposed and approved changes are identified by number and title in the minutes of each meeting, which are published by a chairman.

• **Management decision** — After management accepts planning as an indispensable instrument for decision making, a complete and thorough implementation of the plan must follow. This must first come from the highest level of management. To have continued effectiveness, it requires that planning be understood by top, middle, and supervisory levels of management.

It requires that decisions be made at these levels. To ask the Project Planning Department for a decision that belongs to management is unrealistic, Vincent stressed. ⌘

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GENERAL DYNAMICS

GD ASTRONAUTICS

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General Dynamics/Astronautics, a Division of General Dynamics Corporation, is dedicated to the advancement of man's knowledge of the universe. It was created to develop the Atlas Intercontinental Ballistic Missile and to expand the company's activities in space flight.

Besides being the free world's first operational ICBM, the Atlas plays a major role in many space programs. It is scheduled to launch more than 100 space vehicles in the sixties for Air Force satellite programs and such projects as Atlas-Mercury, Atlas Agena B, and Atlas-Centaur.

Immediate Openings Exist in the Following Areas:

Test Laboratory

Requires a minimum of a BS degree in Engineering or Physics, with two to five years of experience in mechanical and/or electronic components design or test. Assignment will be in one of three laboratories: (1) pneumatics and gas dynamics; (2) environmental, pressure and vacuum; (3) autopilot, missile tracking, range safety, and components test.

Structural Design

BSAE or ME for the design of airborne structures including fairings, fixtures and basic missile body structures. Previous aircraft or missile structural design experience required.

Systems Test Engineering

BSEE or ME, plus five years of system design and test experience. Duties include analysis of customer technical objectives and the preparation, monitoring and review of missile test plans. Also required to review and approve customer requirements for captive and live flight tests. Knowledge of at least one of the following required: Structures, Hydraulics, Pneumatics, Guidance or Launch Control Logic.

Mechanical Design Engineering

BSAE or ME; to design and develop missile air frames, ground support equipment, hydraulic or pneumatic systems.

Electronic Engineering

BS or MSEE with applicable experience; to be assigned to telemetry, radiation systems, trajectory measurement, tracking, guidance, automatic controls, packaging, instrumentation, digital devices, printed circuitry, logic design, component and systems testing or measurement systems. Openings exist in design, development, reliability, vendor qualification selection, and test on ground and airborne electronic components, sub-systems and systems.

Electrical Design Engineering

BS or MSEE with applicable experience required; to be assigned to launch control systems design, packaging, test equipment, missile electrical power systems or component and systems testing. Openings exist in design, development, vendor qualification selection, and test of ground and airborne missile electrical equipment.

Reliability Engineering

BS in AE, EE or ME with systems test or analysis background; to establish reliability requirements, conduct testing and analysis, and maintain reliability program surveillance.

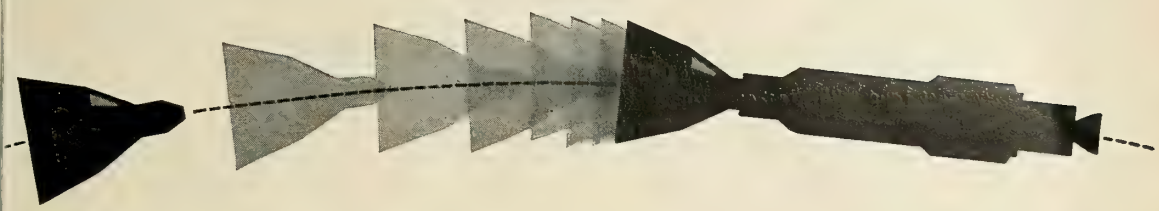
Openings also exist in these other specialties:

Circuit Design, Data Transmission, Guidance Systems Analysis, Microwave Design, Dynamics, Thermodynamics, Weights, Stress Analysis, Flight Test, Electromagnetic Interference Control, Field Test, Scientific and Business Programming, Engineering Writing.

If the inquiry card has been removed, or if you wish to furnish or request more detailed information, please write to Mr. R. M. Smith, Chief of Professional Placement and Personnel, Mail Zone 130-90, General Dynamics | Astronautics, 5755 Kearny Villa Road, San Diego 12, California.

GD

GENERAL DYNAMICS | ASTRONAUTICS



GEMINI

first manned rendezvous in space

How do you dock a two-man spacecraft with another vehicle in earth orbit? What happens when astronauts are weightless for a week or more? Project Gemini is calculated to answer these vital questions. The test of rendezvous techniques alone is a crucial experience in man's drive for the moon —and the results will be invaluable.

Unusual capabilities are needed to solve the intricate and demanding problems of Gemini (and, after Gemini, Apollo).

NASA needs senior aerospace engineers with 6 to 10 years experience in . . . . Systems analysis and studies • Systems engineering • Spacecraft and flight missions • Reliability assessment • Launch vehicles and propulsion • Systems integration and checkout.

NASA offers you unequaled resources and unlimited opportunities for professional growth and recognition. Send just one resume to NASA, Director of Professional Staffing, Dept. 502, NASA Headquarters, Washington 25, D.C. Positions in various locations and in other disciplines—many requiring less experience—are also available.

All qualified applicants will receive consideration for employment without regard to race, creed or color, or national origin. Positions are filled in accordance with Aero-Space Technology Announcement 252-B.

Information from countless sources, staggering amounts of it. New information that changes from moment to moment, old information that must be retrieved from storage in seconds. Information of world importance. This is what command decisions are based on: This is what a new science-technology must cope with to help make command decisions possible. The science-technology of which we speak involves the development of far-reaching man-machine systems to provide information processing assistance for military and government leaders. The needs of this field have created a number of new positions at System Development Corporation. Our scientists, engineers and computer programmers applied this science-technology to help develop SAGE. We now apply it to our work on the SAC Control System and other command and control systems being developed. At SDC, our staff participates in key phases of system development; analysis, synthesis, computer instruction, system training and evaluation. Human Factors Scientists, Operations Research Scientists, Engineers and Computer Programmers interested in joining this expanding new field are invited to write Dr. H. L. Best, SDC, 2433 Colorado Ave., Santa Monica, Calif. Positions are open at SDC facilities in Santa Monica; Washington, D.C.; Lexington, Mass.; and Paramus, N.J. "An equal opportunity employer."

SDC

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PHOTOGRAPHS BY USAF, NASA AND UPI



Atlas, Titan II To Aid 'Hitchhikers'

GE-Air Force program has already provided nose cone space for more than 140 experiments; how to apply

by Heather M. David

DEVELOPMENT FLIGHTS of *Atlas* and *Titan II* nose cones are expected to afford new opportunities for "hitchhiker" experiments in the coming year.

Although the exact number of vehicles available has not been determined, General Electric MSVD is continuing its agreement with the Air Force to administer a Space Laboratory Program in ballistic missile test flights. Observers expect the addition of the *Titan II* to the program will increase the availability of space. The program has heretofore been conducted with *Thor, Thor-Able* and *Atlas* rockets.

More than 140 experiments have already been flown in the joint BSD-GE/MSVD program, on more than 44 flights. More than 60% of these have returned useful data.

The Space Laboratory Program is carried as ballast on checkout flights of IRBM's and ICBM's. Since checkout gear usually does not weigh as much as the design payload, ballast of some sort must be provided. As long as primary flight objectives are not compromised, the flight can be used as an experimental facility.

Modest cost is insured, since boosters, vehicles, telemetry links and in some cases the recovery system are paid for by the Air Force. Once the Air Force has approved the program, the Space Lab experimenter need only observe limitations of minimum interference to the weapons system program.

Unique re-entry trajectories—which have not been simulated on the ground —are available to the Space Lab experimenters. Flights reach altitudes of 750 miles or more—regions not accessible by any other means.

• **How to apply**—Military and civilian researchers must first get approval from the Air Force Systems Command. AFSC directs requests to the proper Ballistic Systems Division vehicle project office, which determines whether the experiment meets requirements of practicality and non-interference.

General Electric then provides certain services:

—Systems engineering consultation to help the sponsor design the experiment and package it so that it will survive the flight environment.

—Fabrication of hardware, if researcher so desires.

—Integration of experiment into the vehicle, including modifying the vehicle if necessary and within the limits of non-interference.

—Integration of range facilities and capabilities, to support each experiment. (Jointly with the Air Force.)

—Checkout assistance, within vehicle at factory and at the range.

—Support at launch, retrieval of down-range tapes, and reduction of data (via GE computers) to a form (digital, analog or punched cards) to facilitate the sponsor's analysis and evaluation.

Low cost has been a goal in all phases of the program. Payment is made directly to AFSC, which in turn reimburses GE for its services.

Frequent meetings are held between experiment sponsors and those at working levels of the program. And as far as security regulations permit, the sponsor is permitted to adjust and check out his equipment on the vehicle.

Several experiments can be conducted on each flight, a fact which GE spokesmen say enhances the value of the separate measurements. One RVX 2A *Atlas* nose cone held 18 different experiments.

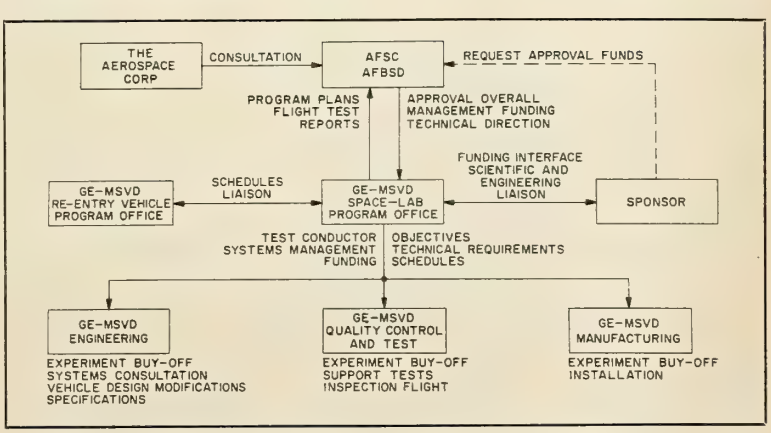
• **Past accomplishments** — In this flight, the Air Force wished to determine the performance of new ablation materials and to study the dynamics of the vehicle. Experiments in the nose cone covered hardware development, meteorology, space environment, hypersonic re-entry, materials and structures.

Among Space Labs' most spectacular experiments were those flown in the development of IR sensors, magnetometers, suntrackers, space cameras and subsystems for 3-axis stabilization of Mark 2 re-entry vehicles in flight.

Another piggyback experiment yielded results which established the quantitative IR emanation level between Earth and the space at the horizon. Hardware subsequently was developed from these results, culminating in the first closed-loop, two-axis IR horizon-stabilized space flight.

The first successful Earth-magnetic-flux measurements from outer space were taken on a Space Labs flight. Development flights were made for stabilization, orbit control, and space power system components. These led to developments which are now being utilized in current satellite programs, including *Nimbus, OAO,* satellite work for NASA and space power programs for Army, Air Force and NASA.

"Backward" looks into space were



ORGANIZATION CHART shows how Space Laboratory Program works.

MARK 2, RVX-1, RVX-2 FLIGHTS ON THOR THOR-ABLE AND ATLAS		RVX-2A FLIGHT ON ATLAS	
EXPERIMENT	SPONSOR	EXPERIMENT	SPONSOR
IR HORIZON SENSORS	AFBMD/GE	COLOR AND B&W CAMERAS	GE/CRC
SUNTRACKER	AFBMD/GE	BIO-SPECIMENS (3 MICE)	AFSAM
MAGNETOMETERS	AFBMD/GE	ULTRA VIOLET BACKGROUND	WADD
TWO-AXIS STABILIZED VEHICLE	AFBMD/GE	RADIATION MEAS OF LOWER VAN ALLEN BELT	LRL
THREE AXIS STABILIZED VEHICLE	AFBMD/GE	GROSS RADIATION MEAS INSIDE VEHICLE	LRL
SATELLITE ORBIT CONTROL	AFBMD/GE	COSMIC RADIATION	CRC
VIBRATION AND NOISE MEAS	AFBMD/WADD	PROTON MEASUREMENTS	LASL
HIGH ALT PHOTOGRAPHY	AFBMD/AFCRC/GE	RADIATION MEAS INSIDE VEHICLE	LASL
MICROMETEORITES	AFCRC	DOSIMETER	AFSWC
VAN ALLEN BELT RADIATION	AFBMD AFLRC/AEC	EMULSION PACK	NASA
ELECTRIC FIELD	AFCRC	HOT GAS SPECTROGRAPH	GE
ION DENSITY	AFCRC	MHD PLASMA CHARACTERISTICS	STL
ELECTRON DENSITY	AFCRC	INTEGRATING ACCELEROMETER	GE
ATMOSPHERIC DENSITY	AFCRC	PASSIVE TRANSPIRATION COOLING	GE
RADIO PROPAGATION	AFBMD/GE/AFCRC	REGENERATIVE FUEL CELL	GE
RE-ENTRY SHOCK	AFCRC	S-BAND REFLECTIVITY	GE
PARTICLE DISPERSION	WADD	X BAND REFLECTIV TY	GE
SOLAR POWER CELL	GE	COSMIC NOISE	GE

BREAKDOWN into categories of previous experiments on Thor, Thor-Able, Atlas.

made possible when a flight was made to determine the orienting characteristics of the Mark 2 re-entry vehicle if it should re-enter backwards. The camera employed as a backup to the attitude telemetry provided the first space films of the Earth, which were widely publicized in 1959. Motion pictures subsequently were taken from altitudes up to 800 miles.

Some 35 separate emulsion stacks have been flown to make observations on the lower Van Allen Belt radiation. Some of the participating experimenters include: Armstrong, Heckman and Rosen of Los Alamos, Freden and White of Livermore Radiation Laboratory, Lindner of STL, Yagoda of AFCRL and Naugle of NASA.

Micrometeorite and ambient electrostatic field and vehicle charge experiments have also produced significant results.

Several biological experiments have been conducted, including the famous Sally, Moe and Amy space mice. Two generations of mice have since been derived from these animals, with no genetic deviations or abnormalities.

A substantial number of aerodynamic data have been obtained by installing piggyback rate gyros, accelerometers, pressure ports, calorimeters and other sensors on vehicles. New techniques of flow field analysis evolved directly from Space Lab experiments.

Heat transfer and ionization data secured from Space Lab flights have contributed to the success of current heat shield and communication equipment design.

According to GE spokesmen, the physical state of plasma around re-entry bodies has also been revealed to some extent by studies of the distortion of a magnetic field produced by the flow.

Materials and structures studies produced results which drew attention to the importance of the aerodynamic shear and noise levels encountered in flight. In some of these experiments, flight char retention was lower and erosion rates shown by sensors and inspection of the recovered vehicle higher than ground extrapolations predicted.

• **Future** — As larger boosters are flown, the Space Labs concept will have even more opportunity to expand. GE conceives of a booster-to-vehicle adapter section, equipped with piggyback payload telemetry and power facilities. After prime vehicle separation, this section would separate and after flight burn up during re-entry.

Another concept is a rocket propelled vehicle housed within the adapter section. Upon separation, gyros would determine the proper attitude when the Space Lab vehicle should be fired into orbit or deeper space. About 100 lbs. net payload could be used in some current weapons system R&D flights, GE says.

If *Nova* and *Saturn* booster tests can be utilized, Space Labs capability reaches an aggregate of tons per year, flying at least in a ballistic trajectory.

GE says the only hurdle to making full use of all the facilities available is one of management—publicizing the fact that opportunities exist, and convincing weapons system management of the need for the piggyback program.

Among other benefits, the company says, is the fact that experimenters can "afford to relax our sophisticated standards and approach some of our problems the way they should be—on an experimental basis—thus saving again in many instances, time and money." ⁂



ITT's Seismometer For Surveyor Spacecraft

LUNAR SEISMOMETER designed to detect quakes and other disturbances on the Moon has been produced by ITT Federal Laboratories as part of the Surveyor lunar landing vehicle being developed by Hughes Aircraft Co. under technical direction of NASA's Jet Propulsion Laboratory. The unit was designed by seismologists of the Lamont Geological Observatory of Columbia University. The seismometer will rest on the lunar surface like a stethoscope, detecting and transmitting back to Earth vibrations on and beneath the surface. Since the Moon's background noise is believed to be much lower than that on the Earth, this seismometer is designed to be considerably more sensitive than terrestrial instruments. Its complex electromechanical design will "cage" each part until safe landing.

The Industry Week

Industry Trends and Forecasts

Sylvania Electronic Systems, division of Sylvania Electric Products Inc., reported a record-high defense backlog as of June 30 of $175 million . . . New orders for cutting-type machine tools for the first half of 1962 equalled those booked during the same period of 1961. A 15% increase in domestic orders during the period offset the 34% drop in foreign orders . . . *First-day covers commemorating all major U.S. space launches are available to philatelists from Space Craft Covers, P.O. Box 2296, Huntington, West Virginia . . .* Linde Co., Division of Union Carbide Corp., will increase liquid oxygen and nitrogen capacities by 230 tons per day at its Essington, Pa., facility. Company spokesman says this is the first in a series of expansions planned over the next few years and timed to meet increasing demands for liquid oxygen and nitrogen in the Eastern U.S. . . . *The Manufacturing Chemists' Assn., Inc., has scheduled two safety workshops on the West Coast in October for "anyone in the chemical or allied industries who has an interest in the safe manufacture, handling and use of chemicals." The dates are Oct. 1 in San Francisco, and Oct. 2 in Los Angeles.*

New Industry Facilities

Otis Elevator Co.'s Defense and Industrial Div. established a new manufacturing facility near Santa Ana, Calif. The electronics manufacturing plant will serve as the Western division headquarters of the Otis D&I group serving 11 Western states . . . *Lockheed California Co. opened a basic science lab at the company's advanced research center, near Saugus, Calif., to explore "the fields affecting man's aerospace future."* . . . Vitro Corp. of America will build a $1.1-million addition to its R&D laboratory in Silver Spring, Md. Completion of the 67,000-sq.-ft. wing is scheduled for the fall of 1963 . . . *Bundy Electronics Corp. moved to a new plant in Springfield, N.J.* . . . Royal Research Corp., subsidiary of Royal Industries, Inc., Pasadena, Calif., began construction of a new plant. The company is engaged in R&D in the nuclear field and manufactures specially designed enclosures for safe handling of radioactive and other hazardous materials . . . *Northern Research and Engineering Corp. is moving its engineering offices and laboratories to new offices in Cambridge, Mass.* . . . Fabri-Tek, Inc. magnetic memory manufacturer, more than doubled its production space with an addition to its plant at Amery, Wis. The company manufacturers memory planes and stacks for the electronic computer industry . . . *The General Time Corp. opened a new Environmental Test Lab at its Central Research Lab in Stamford, Conn. Equipment includes units to test effects of vibration, shock, temperature-altitude, temperature-humidity, rotary acceleration and salt spray on a wide variety of items . . .* Infrared Industries, Inc. will move its corporate headquarters to Santa Barbara, Calif. . . . *General Atronics Corp. opened a new R&D facility at Arlington, Mass. Present plans call for specialization in theoretical studies for the communication field and signal handling for radar.*

Industry Guides Published

The 1962 edition of "Aerospace Facts and Figures," official Aerospace Industries Association publication, is now on sale. Partial contents of the 168-page book include data on missiles, rockets and drones in production; record of development and production expenditures to date; data on all satellites and space vehicles in production or research; Federal appropriations for R&D, by military services and other Government agencies concerned with the aerospace industry; labor statistics; and a survey of aerospace export activities. The book is available for $3 per copy from American Aviation Publications, 1001 Vermont Ave., N.W., Washington 5, D. C. . . . *A 64-page pamphlet detailing changes in the tax depreciation system, amounting to a $1.5 billion "tax cut" for business, has been published by the Government Printing Office. "Depreciation Guidelines and Rules" is available for $.25 from the Superintendent of Documents, Government Printing Office, Washington 25, D.C.*

International News Briefs

Geoscience Instruments Europe has been formed in Copenhagen, Denmark, by Geoscience Instruments Corp. to serve the Common Market. The company will stock equipment and supplies required in preparation of critical surfaces—high-precision, ultra-flat, perfected polished surfaces. The company is also setting up a facility for processing semiconductor materials, and will be able to slice, lap and polish silicon crystals, laser rods and ferrite components.

News Of Mergers and Acquisitions

Deutsch Co., Los Angeles, acquired the electrical connector products section of Consolidated Electrodynamics Corp., subsidiary of Bell and Howell. Cash transaction will add about 10% to Deutsch's $15 million annual sales volume . . . *Hycon Manufacturing Co., Monrovia, Calif., purchased Hayward Scientific Glass Corp., Whittier, Calif., which will operate as a wholly owned subsidiary. All Hayward engineering and production facilities will be moved to the Hycon facility in Monrovia . . .* Goodrich-High Voltage Astronautics, Inc., became a wholly-owned subsidiary of High Voltage Engineering Corp. The company, formerly jointly owned with B. F. Goodrich Co., will be called Ion Physics Corp. . . . *Technical Systems Inc. acquired controlling interest in Computer Equipment Corp., Los Angeles manufacturer of electronic cable and quantizer instruments . . .* Litton Industries, Inc., acquired The Poly-Scientific Corp., Blacksburg, Va., developers and producers of specialized components for precision instruments. P-S will operate as a division of Litton's Components Group.



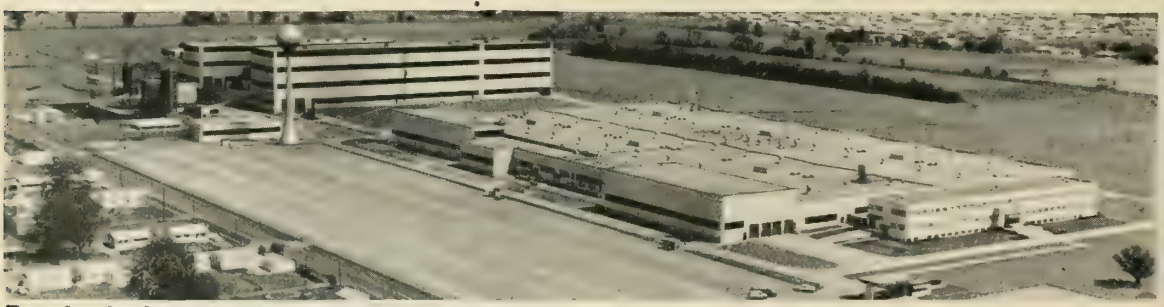


Clarification: Nimbus Telemetry; Goldstone Antenna

CORRECTION: In the August 6 issue, on page 15, M/R inadvertently printed the photo at right above a caption describing the photo at left. The picture at left is the first released photo of the ground telemetry station which will receive, process and display PCM telemetry data from the Nimbus weather satellite. It was built by Radiation Inc. under NASA's direction. At right is a photo of a 195-ton antenna, used by Jet Propulsion Laboratory at the Goldstone tracking station, being moved to a new location five miles across the Mojave Desert.

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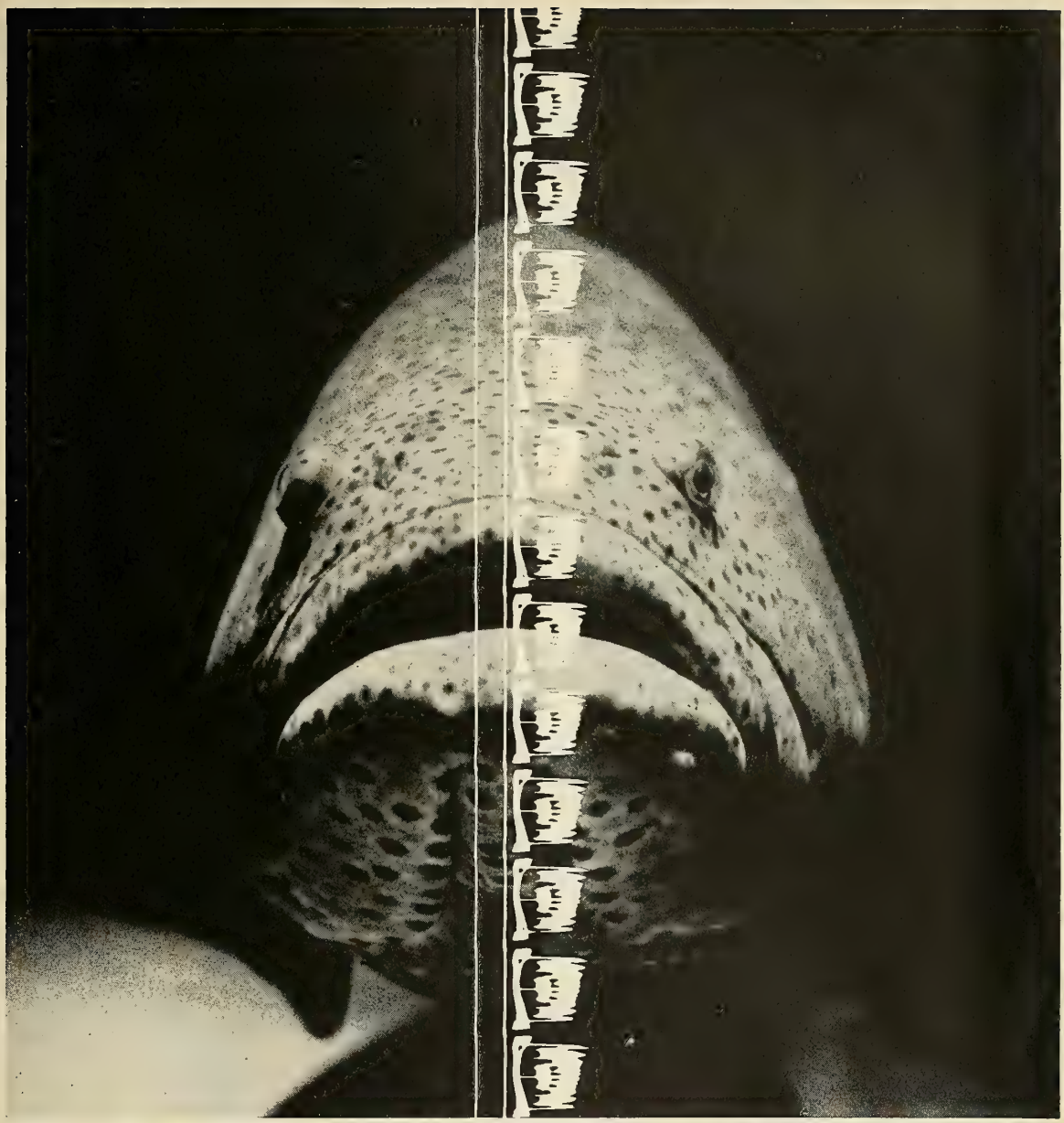


Particularly suited to missile or rocket production

Has High Bay Building, a Tank and Plate Shop and general manufacturing building, many other outstanding features. Heights from 20′ to 81′, floor to bottom of truss. The 3 manufacturing buildings have receiving and shipping areas fully serviced by truck and rail (NYC, Pennsylvania, Milwaukee Road and C&EI), covered with 10-ton to 200-ton crane facilities. Office equipment and furniture also available. The 48,000-sq-ft, 3-story office building is of brick and concrete, also has large cafeteria and kitchen. Site is attractively landscaped and completely fenced.

ALL CONSTRUCTION — 1952 through 1956. **BUILDINGS** — Manufacturing buildings are of tilt-up concrete panels and insulated Transite. **PARKING** — 1,400-car cap. surfaced. **POWER** — from 138,000-v line; own main substation; 138-kv, 1,200-amp oil circuit breaker, 5,000,000-kva interrupting capacity; two-7,500-kva main transformers. **HEATING** — boiler house with 94,250-lb steam-per-hour capacity; 500-ton coal storage silo; vacuum ash silo. **FIRE PROTECTION** — 500,000-gal. reservoir; underground mains supply sprinkler system of each building; 150,000-gal. water sphere 125 ft high; complete alarm, signal, call system. 365

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special report ...space electronics

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- Market forecast through 1970
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  - . . . guidance, control, and navigation
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  - . . . checkout systems
  - . . . APU's
  - . . . electronics requirements for lunar base support systems
  - . . . environmental testing problems

M/R'S 18 MAN EDITORIAL STAFF WILL EMPHASIZE FUTURE PRODUCT AND SYSTEM REQUIREMENTS AS WELL AS EXPECTED MARKET TRENDS. Because of its timeliness and importance, the Space Electronics report will have intense reader impact. Advertising in this issue will benefit from this interest by gaining maximum exposure to 38,064 (submitted to ABC for audit) paid subscribers / 11,506 of them in the top 40 missile-space contractors, the companies responsible for over-all system integration and subletting of electronics contracts / 7,589 readers in NASA, Air Force, Army, and Navy; the organizations directing U. S. space programs.

space reservations by august 27
plates by september 7
issue date: september 17, 1962

MISSILES AND ROCKETS • american aviation publications,




KNOWLES


HAWKINS


DOUGHERTY


HERRE


KANE

William T. Stratton: Appointed manager of the Paris office of Hughes International.

Emiel T. Nielsen, Stuart H. Bear and **Howard L. Shannon:** Elected vice presidents of FMC Corp., San Jose, Calif.

C. H. Knowles: Appointed general manager of the Molecular Electronics Div. of Westinghouse Electric Corp., Pittsburgh.

Major J. C. Camp (USMC ret.): Appointed administrator of network systems for Ingersoll Kalamazoo Div. of Borg-Warner Corp.

George W. Ledbetter: Appointed western representative of TKM Electric Corp., Rochester, N.Y.

Dr. George Gerard: Appointed director of engineering services of Allied Research Associates, Inc., Boston.

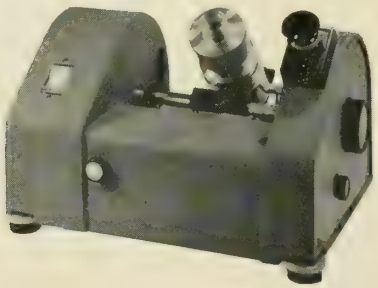
Gerald E. Donovan: Elected to the board of directors of Marshall Industries, San Marino, Calif.

Robert A. Hawkins: Appointed manager of the Lowell plant of Avco Corp.'s Research and Advanced Development Div., Lowell, Mass.

Robert R. Gilruth: Director, NASA's Manned Spacecraft Center, selected by President Kennedy to receive the 1962 President's Award for Distinguished Federal Civilian Service.

Frederick E. Croxton, Jr.: Named director of the Redstone Scientific Information Center, Redstone Arsenal, Ala.

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TILTING PISTON GAGE to 0.000002 psi RESOLUTION

Resolution:
Low Range—0.000002 psi to 0.000150 psi
High Range—0.000020 psi to 0.005 psi

Repeatability:
0.01% of full range in the range of 0-.3 psig; 0-2 psig
0.01% of reading in the range 0.3-15 psig; 2-600 psig

Ranges:
1) 0-15 psig 2) 0-600 psig

Increments:

0.000030 psi	(0-.3 psi range)
0.00030 psi	(0-2 psi range)
0.01 psi	(0.3-15 psi range)
0.4 psi	(2-600 psi range)

Reference Pressure:
Atmospheric or Vacuum

Pressure Medium:
Gas

The Tilting Piston Gage is an extremely accurate, air-lubricated dead weight pressure calibrating instrument. Measurements from 0 psig are obtained by tilting the piston-cylinder assembly from the horizontal to vertical position. Weights are then loaded on the piston for higher pressures. *A mechanical Weight Loader can be added to the instrument to permit changing weights without disturbing a vacuum reference pressure.

AIR PISTON GAGE

The companion instrument, the Air Piston Gage uses the same piston-cylinder assemblies as the Tilting Piston Gage only housed in a simpler base.



Optional Accessories, both units: 1. Weight Loader 2. Pressure Control Pack

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Dr. John L. Zambrow: Appointed manager of metallurgy research for the Roy C. Ingersoll Research Center of Borg-Warner Corp., Chicago.

Marvin B. Ruffin: Elected president and chief executive officer of Bogart Manufacturing Corp., Brooklyn, N.Y.

H. F. (Bud) Dougherty: Appointed sales manager of the northern California division of Components Corp., San Jose, Calif.

Col. Albert R. Shiely, Jr.: Named program director of the Air Force's Ballistic Missile Early Warning System (BMEWS).

Gustav E. Schrader: Appointed vice president and director of Sifco Metachemical, Inc, Cleveland.

Harry A. Keit: Appointed director of the system design division for International Electric Corp., Paramus, N.J.

H. T. Deverell: Appointed executive engineer responsible for all product engineering for Kent Manufacturing Corp., Hillside, N.J.

Donald W. Kallstrom: Appointed quality control manager for the Pelmec Div. of Quantic Industries, Inc., San Carlos, Calif.

John M. Evans: Promoted to special projects engineer in the Industrial Engineering Dept. of Armstrong Cork Co., Lancaster, Pa.

Robert T. Campion and **John J. Burke:** Elected senior vice presidents of Lear Siegler, Inc., Santa Monica, Calif.

John J. Herre: Appointed vice president, government relations of General Instrument Corp.'s Radio Receptor Div., Hicksville, N.Y.

B. D. Loughlin: Elected vice president for research of Hazeltine Research, Inc., Little Neck, N.Y.

W. Jerome Kane: Appointed vice president and general manager of Boeing International Corp., Seattle.

Carl David Todd: Appointed head of engineering of Hughes Aircraft Co.'s electronic products division, Newport Beach, Calif. **Richard S. Simpson** named supervisor of production engineering of the packaged assemblies department.

Alan Schwartz: Appointed vice president of Mansol Ceramics Co., Belleville, N.J. **T. G. Rabito** appointed senior chemist in the organic department.

Robert G. Hoof: Appointed director of marketing for B. H. Hadley, Inc., Pomona, Calif.

Clarence A. Gunther: Appointed division vice president, technical programs, Radio Corp. of America, New York City. **N. Richard Miller** appointed division vice president, business planning.

New Avenues in Space Technology ... at AVCO/RAD

Addition of the vital Apollo Heat Shield to Avco/RAD's Minuteman, Titan, Atlas, and Penetration Aid program has created new opportunities for Senior Scientists and Engineers qualified in the following areas:

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Development and Design Procedures
Material Thermal Performance Evaluation
Preliminary Design

★ **AERODYNAMIC DESIGN & DEVELOPMENT**

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Vehicle Dynamics
Aerodynamic Loads
Wind Tunnel Testing
Preliminary Design
Configuration Optimization
Heat Transfer

To support these activities the Division's 23 million dollar facilities, located just north of metropolitan Boston, has recently added a new space research laboratory to simulate conditions encountered by vehicles returning to earth after lunar and interplanetary missions.

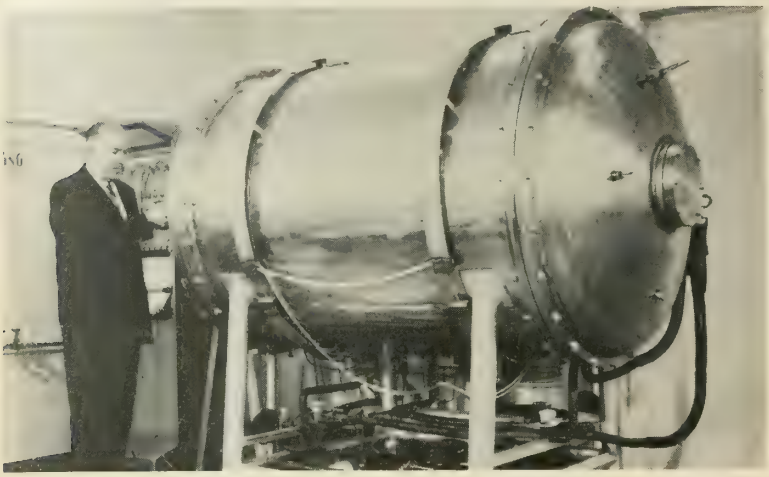
Featuring facilities such as an MHD shock tube and molecular beam shock tunnel to accelerate gases to 60,000 feet per second, the new addition extends the Division's capability to offer scientific and technical personnel the proper atmosphere and equipment to carry out assigned and future programs.

Send resume to
Mr. J. Bergin
Dept. JS

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Research & Advanced Development
A Division of Avco Corporation
201 Lowell St., Wilmington, Mass.

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New Product of the Week: 1000-mile Altitude Space Simulator

ILIKON CORP. has developed a 75-cu.-ft. stainless steel altitude chamber capable of operation down to the low 10^{-11} mm Hg ranges or equivalent to space conditions existing over 1000 miles above Earth. The 4-by-6-ft. chamber has full-opening doors at either end utilizing refrigerated O-ring seals. The pumping system has a 4200 liter/sec. oil diffusion pump.

A refrigerated cold-cap and plate baffle insures the lowest possible rate of oil backstreaming. Nitrogen consumption rate is less than 4 liters per 8 hours. Two 7.5-in.-diameter windows and a multitude of electrical feedthroughs are available.

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jpl needs

SENIOR ELECTRONIC ENGINEERS

DIGITAL COMMUNICATIONS TECHNIQUES

To lead communication demodulation development employing programmable or general purpose digital machines. Study and development is long term, aimed at developing practical demodulation hardware for ground station use. Applicant should have MSEE or better and be interested in making a practical contribution to spacecraft reception implementation.

Send complete resume to
PERSONNEL DEPT. 334

JET PROPULSION LABORATORY
CALIFORNIA INSTITUTE OF TECHNOLOGY
4808 OAK GROVE DR. • PASADENA, CALIF.
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Measurement Calibrator

The RU-II "Run-Up," a portable instrument for use in calibrating measurement and control devices that consume power, such as millivoltmeters, milliameters, sensitive relays, PH meters, and valve positioners, is available from Technique Associates. The unit combines a millivolt and milliampere "run-up" source, with three ranges—0-25, 0-100 MV, and 0-50 MA at 50 v. d-c—for checking the latest types of process controllers and amplifiers. Power source is a Burgess Z 60-BP battery or equivalent. At full power output, the instrument will operate continuously for 3.5 hours.

Circle No. 226 on Subscriber Service Card

Pulse Rate Integrator

A compact portable cabinet for the Anadex Model PI-400 Pulse Rate Integrator module is being marketed by Anadex Instruments, Inc. The Model HR-1 Portable Cabinet Rack is designed for the user who requires only one PI-400 unit, or who desires the convenience and versatility of a portable unit.

The Anadex Model HR-1 Portable Cabinet Rack contains both a power supply and crystal-controlled calibration generator for the PI-400. The unit operates from standard line power of 115 v a-c 60 cycles and provides 5 calibration frequencies, one for each frequency range of the PI-400.

Circle No. 227 on Subscriber Service Card

Reflex Klystron

Metcom, Inc., is marketing the 6310 reflex klystron, designed for plug-in electrical operation and equipped with a single screw tuner for ease in changing frequency.

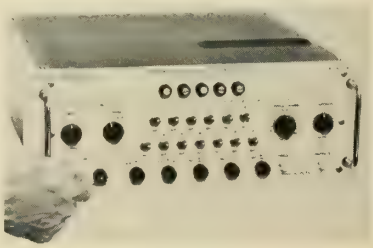
The 6310 has smooth single-screw tuning in the X band from 8.5 to 10.0 kmc with 70 mw power output over the entire range. Tuner is set for a uniform 60 in./oz. torque over the entire range.

Circle No. 228 on Subscriber Service Card

Telemetering Calibrator

Long-term frequency accuracy of ±0.002%, all-solid-state circuitry with no mechanical stepping switches and extremely compact module construction are featured in a simultaneous five-point calibrator developed by Panoramic Electronics, Inc. Model TMC-505, is used to measure subcarrier discriminator linearity on all IRIG FM/FM telemetering channels simultaneously in a few seconds.

The low-cost TMC-505 supplies 50



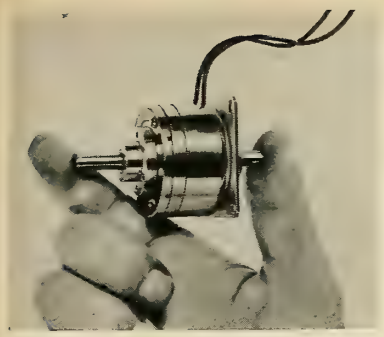
calibration frequencies equally spaced from center frequencies of the 18 standard IRIG channels (±7.5% max. deviation) plus the five optional channels (±15% max deviation). All frequencies are accurate to ±0.002% over many months.

Circle No. 229 on Subscriber Service Card

Electromagnetic Brake

Electroid Corp. is marketing an electromagnetic brake, clutch and coupling set with a 1¾ in. diameter and 10 lb./in. static torque.

Called the Model EC-17-B (brake), Model EC-17-C (clutch) and Model EC-17-CC (clutch coupling), the three units are used where rapid stops are



required in computer drives, winding machinery, magnetic tape drives and recorders.

The brake is supplied with a standard 90 or 24/25 volt d-c coil and armature bores of ¼ in. and ⅜ in. The stationary field clutch armature, Model ED-17-C is adaptable to gear, sprocket and sheave methods of transmission.

Circle No. 230 on Subscriber Service Card

High-Pressure Helium Valve

A high-pressure ball valve for helium gas service is available from Flodyne Controls, Inc. The valve is designed for applications requiring minimum pressure drop and bubble-tight sealing at pressures of 6000 psi and above.

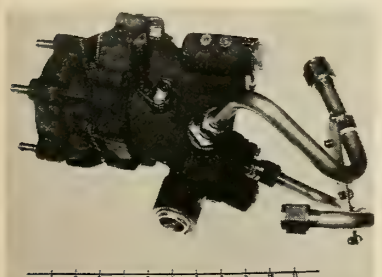
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Hydraulic Motor

The Aerospace Division of Vickers Inc., Division of Sperry Rand Corp., has announced the availability of constant-speed, variable-displacement hydraulic motor slated for use on air-to-surface missiles.

The motor will be used to drive a 10 KW a-c generator. This application involves extensive no-load operation at relatively high inlet-oil temperatures of approximately 225°F. Speed regulation of the unit is ± 1%.

Inlet flow requirements vary, while driving the generator at 8000 rpm,



from 415 gpm to 14 gpm depending upon electrical power demand. Peak overall efficiency at full stroke is 82%. The unit is capable of up to 28 hp at a peak flow capacity of 22 gpm and a speed of 8000 rpm.

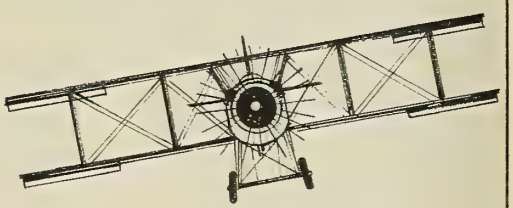
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Submit your resume to: Professional Placement, Dept. MR-8

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contracts and procurements

AWARDS

AIR FORCE

$200,000,000—**General Precision, Inc., Aerospace Div.,** Little Falls, N. J., for development of stellar inertial guidance and control system for new *Mobile Mid-Range Ballistic Missile.*

$28,550,000—**Boeing Co.,** Seattle, for continued assembly and maintenance of equipment at *Minuteman* missile sites (5 contracts).

$20,400,000—**Thiokol Chemical Corp.,** Brigham City, Utah, for continued production of *Stage I Minuteman* rocket motors (3 contracts).

$17,600,000—**Aerojet-General Corp.,** for work on second stage *Minuteman* rocket motors at Sacramento, Calif.

$17,000,000—**Atlantic Research Corp.,** Alexandria, Va., for provision of information to enhance ballistic missile effectiveness at lower costs than would be incurred by experimentation through use of special solid propellant test vehicles.

$10,500,000—**North American Aviation, Inc.,** Downey, Calif., for continued production of *Minuteman* guidance and control systems.

$5,000,000—**Philco Corp.,** Palo Alto, Calif., for work on control subsystems for space programs (supplemental contract).

$4,795,129—**General Dynamics Corp.,** San Diego, Calif., for installation and checkout of *Atlas* missiles at Vandenberg AFB and modification of B-58 bombers at San Diego (3 contracts).

$3,500,000—**Aerojet-General Corp.,** New York City, for research and development and related work for *Stage II Minuteman* (supplemental contract).

$3,488,888—**Boeing Co.,** Seattle, for work on *Minuteman* weapons systems.

$3,000,000—**Douglas Aircraft Co.,** Santa Monica, Calif., for research and development on the *Skybolt* weapon system (supplemental contract).

$2,890,000—**Hughes Aircraft Co.,** Culver City, Calif., for production of *Falcon* missiles and related items.

$2,600,00—**Paul Hardemann, Inc.,** Stanton, Calif., for installation and checkout of propellant transfer systems at Stanton, Vandenberg, Davis-Monthan, McConnell and Little Rock, AFB's.

$2,335,270—**General Dynamics Corp.,** San Diego, Calif., for spare parts for *Atlas* missiles.

$2,046,853—**General Dynamics Corp.,** New York, for airborne ground support equipment for *Atlas* missiles (supplemental contract).

$2,000,000—**General Dynamics Corp.,** New York, for installation and checkout of *Atlas* missiles.

$1,627,123—**Chrysler Corp.,** Detroit, Mich., for modification kits for missiles.

$1,416,000—**Lockheed Aircraft Corp.,** Sunnyvale, Calif., for research and development of space systems.

$1,000,000—**Lockheed Aircraft Corp.,** Burbank, Calif., for work on space vehicles at Sunnyvale, Calif.

$442,000—**Acoustica Associates, Inc.,** Los Angeles, Calif., for production of propellant utilization systems and engineering and support services in the *Atlas* program (2 contracts).

$300,000—**Republic Aviation Corp.,** Farmingdale, N. Y., for further development of its plasma pitch engine.

ARMY

$1,024,480—**Eagle-Picher Co.,** for production of batteries at Joplin, Mo., for use in the hydraulic systems of *Nike-Hercules* missiles.

$850,000—**Ryan Aeronautical Co.,** San Diego, Calif., for specialized target operational services with *Firebee* jet drones at White Sands Missile Range.

$480,964—**General Motors Defense Research Laboratories,** Santa Barbara, Calif., for a laboratory study of optical and radar characteristics of simulated missiles re-entering the Earth's atmosphere.

NAVY

$47,000—**Space-General Corp.,** El Monte, Calif., for the preliminary development of a system to extend the search capabilities of ships at sea.

Mare Island Navy Yard, Calif., for construction Va., for construction of a *Polaris* submarine

Shipbuilding & Dry Dock Co., Newport News, Va., for construction of a *Polaris* submarine (undisclosed amount).

Electric Boat Div. of General Dynamics, Groton, Conn., for construction of a *Polaris* submarine (undisclosed amount).

NASA

$15,954,960—**Boeing Co.,** Seattle, Wash., for continued work on *Saturn* rocket.

$896,000—**Pratt & Whitney Corp.,** West Palm Beach, Fla., for coordinated studies between Pratt & Whitney and the Marshall Center to determine the general throttling capabilities of an RL-10 engine in simulated altitude conditions.

AEC

Martin Co.'s Nuclear Div., Baltimore, for investigation of the feasibility of a radioisotope-fueled power plant and development of a conceptual design for a 500-watt power system.

INDUSTRY

$12,803,480—**General Motors Corp.,** Allison Div., Indianapolis, Ind., for **Thiokol Corp.,** for first stage rocket motors for the *Minuteman* missile.

$500,000—**Radio Corp. of America,** New York City, from **Boeing Co.,** for electronic spare parts for a portion of the *Minuteman* missile weapon system.

$469,000—**U.S. Science Corp., subsidiary of United Industries Corp.,** Los Angeles, from the **Aeronautics Systems Div.,** for production of pre-flight testers.

$100,000—**Duff-Norton Co.,** Charlotte, N. C., from **Boeing Co.,** for inverted wormgear jacks for the *Minuteman* missile support systems in underground silos.

General Precision, Inc., Librascope Div., Glendale, Calif., from **Jet Propulsion Laboratory,** for an evaluation of the performance and reliability of spacecraft components.

REQUESTS FOR BIDS

GENERAL PROCUREMENTS

Officer in Charge
Navy Purchasing Office
929 So. Broadway, P. O. Box 5090
Metropolitan Station
Los Angeles 55, Calif.

Polaris gages, granite surface plate sub-assy 100, to be accord/w BuWeps Dwgs. 1870216. Appx. wt. 8200#—Drawing available until supply is exhausted—Drawings may be examined at above purchasing office. Delivery to Los Angeles, Calif. area—2 ea.—IFB 123-22-63 "B"—Bid opening 21 Aug. 62.

Director, *Titan II* Construction Directorate
Corps of Engineers
Ballistic Missile Construction Office
Air Force Unit Post Office
Los Angeles 45, Calif.

Modifications in the field to 57 presently installed sets of blast valves and dampers. The work to consist of: (A) add segmented fillers on head skirt; (B) add assist spring on shock absorber; (C) add relief valve to hydraulic piping; (D) add single-acting spring return hydraulic cylinder; (E) change "reopen" time delay to 90 seconds. Approximate value of the work is $600,000. Four to six months time will be allowed for completion of the work. Work shall be performed at the 57 *Titan II* missile launch facilities near Davis-Monthan AFB, Ariz.; McConnell AFB, Kan.; Little Rock AFB, Ark., and Vandenberg AFB, Calif. Job—IFB ENG-04-548-63-4B—Bid opening not furnished. Bid sets will be available on or about 10 Aug. 62. There is a nonrefundable charge of $5 per set for full size drawings and specifications. No half size drawings available. Request for plans and specifications should be addressed to the District Engineer, U.S. Army Engineer District, Los Angeles, 751 South Figueroa St., Los Angeles, Calif

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Procurement and Production Office
Procurement Div.
Research and Development Br.
Laurence G. Hanscom Field
Bedford, Mass.

Fabrication and delivery of two Cygnus 15 rocket motors, with nozzle and blowout diaphragm, to be negotiated with Aerojet-General Corp., Sacramento Calif. Note: For info only.

Warner Robbins Air Material Area
Robins AFB, Ga.
Attn: Procurement and Production

Spare parts applicable to TM 76B missile weapons systems consisting of: chassis, verification, Martin PN 258N9144001-49, FSC MSSB4935, 7 ea.—program chassiss, Martin PPN 258N9420500-9, FSC MSS4935-777-0999, 1 ea.—programmer, Martin PN 258N9102102-9, FSC 4935-8570812SB, 2 ea. Destinations to be furnished. Complete data not available. Notice is given that specs, plans or drawings relating to the procurement described above are not available and cannot be furnished by the Government.

Directorate, Procurement and Production
Kelly AFB, Texas

2915-532-9950 (P/N 71185) Spring, 200 ea.—2915-730-4835 (P/N 75420) Parts Kit C, 75 ea.—2915-797-2747 (P/N 75199) Cover Assy, 75 ea.—2915-832-4505 (P/N 49381) Washer Key, 344 ea. Applicable to 9433A6 pumps J52P3 engine in support of Gam 77/77A missiles. No drawings or specs are available. Deliver Transportation Officer, Kelly AFB, Tex—RFP SA-2-2915-E-24077 (Q)—RFP due date 29 Aug. 62. Items identified by Chandler Evans Corp., Charter Oak Blvd., West Hartford, Conn. part numbers. Direct inquiries to M. Kirkland, WAlnut 3-5411, Ext. 5630. Kelly AFB, Tex.

Bureau of Naval Weapons
Washington, D. C.

The Bureau of Naval Weapons is contracting with General Precision, Inc., Librascope Div., Glendale, Calif., for the repair (including emergency repair) alteration, maintenance and overhaul of missile and/or gun fire control equipment. This notice is made solely to inform potential subcontractors of the proposed procurement. Small business firms and others interested in subcontracting should contact the above firm direct referencing CN 3237-62. Contract NOW 63-0006-F BUWEPS Synopsis No. 31-63

Directorate, Procurement and Production
Hq. Middletown Air Material Area
Olmstead Air Force Base, Pa.

Contract technical services for GAM 77/77A missile systems including, age, flight controls, guidance system and non-tactical instrumentation for 41 man months. Negotiations will be conducted with North American Aviation, Inc., Downey, Calif. This is an increase of Contract AF 33(600)-43169. For info only. No RFP available.

Big Solid Studies

(Continued from page 13)

NAS 8-2438, has been working in this area for about nine months.

They will determine the ideal stage weight, the best structure for holding the motors and for joining the solid stage to the liquid stages, and how to assemble and launch the vehicle.

Aerojet-General Corp. has been working to analyze the problem of the cluster structure of a solid-propellant stage in relation to the effect on the solid rocket motor. "Aerojet has considerable experience in the design and manufacture of rocket motors, and we expect that they will establish the critical design features," Cohen continued. Design of Interstage Structure illustrates the kind of consideration involved in the Aerojet contract.

One specific problem concerns the method of transmitting the thrust from a number of rocket motors to the interstage, which will then lead to a liquid propellant stage. Some of the technical difficulties involved arise from the fact that it is almost impossible in normal fabrication technology to make a number of large structures, such as rocket motors, with exactly identical lengths. The normal tolerances of manufacture make this impossible.

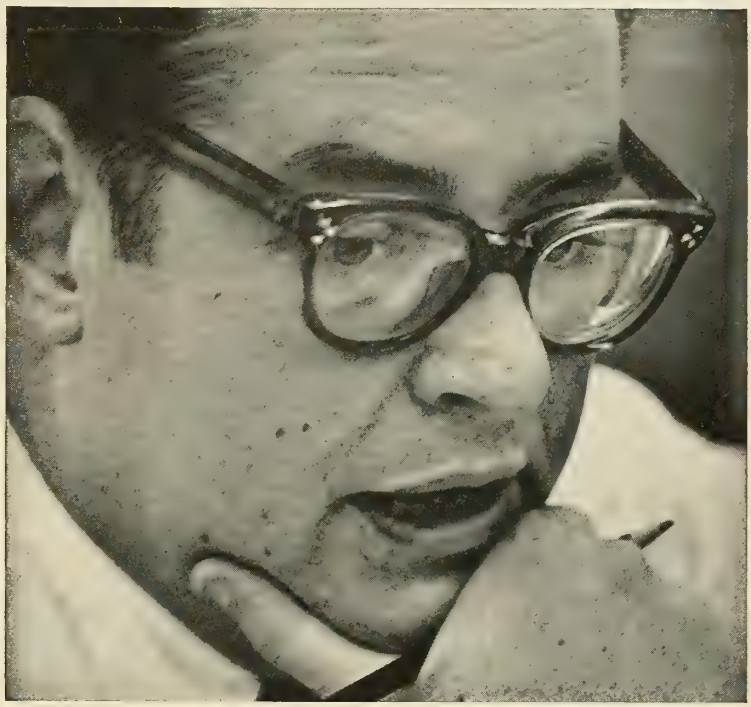
In addition, the ignition of the motor and the subsequent burning produces a pressure in the neighborhood of 700 lbs. per sq. in. inside the motor. This causes the case to stretch. All motors in a cluster do not stretch the same amount because they cannot be made with exactly the same metal thickness, nor do they operate at exactly the same pressure. Furthermore, just to make the problem more interesting, the motor cases will swell or increase in diameter when the pressure rises. Some provision must be made for this.

"Aerojet's contract studies this situation in great detail, and will finally tell us the best clustering design in terms of minimum weight, minimum cost, and of course least effort on the rocket motors," Cohen told the Committee.

Another contractor, Lockheed Propulsion Co., is doing similar work.

Just recently, NASA awarded two new *Nova* system study contracts. One went to General Dynamics Astronautics Division and the other to the Martin-Marietta Co. "The objective of these contracts, which are the normal prelude to any system development work, is to define in detail the best approach to performing the Nova mission. These contractors will give full consideration to solid rocket motors in their studies," Cohen concluded. ❖

Wanted: Men with unmortgaged minds



Northrop-Norair needs men who can see with fresh eyes; men who owe no allegiance to accepted ideas. Headstrong men, impatient for tomorrow.

If the shoe fits, come to Norair—where new lines of investigation open all the time, and no new idea is ever out of bounds. Positions are immediately available for:

Engineers in electronic checkout systems who have worked with advanced design and program development.

Engineers whose background is in supersonic aerodynamics, stability and control, inlet design ducting, and performance analysis.

Engineers familiar with airframe structural analysis.

Scientists specializing in infrared, optics, and electronic research.

Engineers to work in data reduction.

Scientists who know structures research and dynamics.

Scientists who have done supersonic aerodynamic research.

Scientists experienced in working with information and sensing systems, platforms, infrared, sensors, flight controls, airborne computing and data handling systems.

Engineers familiar with programming, operations, and instrumentation for ballistic missile flight test.

Reliability Engineers to assess the reliability and to optimize the configurations and mission profiles of space systems.

Chemical Engineers to work on the development and applications of structural adhesives for aerospace vehicles.

Metallurgical Engineers for research and development on materials and joining.

If you'd like more information about these opportunities and others soon to be available at Norair, write and tell us about yourself. Write Roy L. Pool, Engineering Center Personnel Office, 1001 E. Broadway, Hawthorne, California.

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HICKS CORP., that is

For no other fabricator of rocket engines can approach the Hicks production record.

From the early days of railroading, all through the growth of the automotive and construction industries down to our age of jets and missiles, Hicks has played an important role in the steel industry.

Specializing in spherical and cylindrical motors of large size, in steel and in plastics.

Large enough to do the job . . . small enough to hold costs down.

THE HICKS CORP.
SPACE AGE STEEL PRODUCTS
ASHEVILLE, NORTH CAROLINA

Bioastronautics

(Continued from page 14)

"We can't produce these heavy primaries on the ground, so we had a choice of going to a satellite or a balloon, and picked the balloon program because we have more control, can track it full-time and recover it sooner. We fly the balloons as far north as we can because at the pole there is a channeling of these heavy particles to Earth, where the magnetic field—the Van Allen belts—comes to Earth. The farther we fly north, the heavier the concentration.

"We are using high-altitude flights in the northland as a simulator—to study biological effect of the heavy primaries."

The goal is for 50-60 hours exposure during flights. Smith says if two or four more monkeys are exposed in further flights this year he hopes to have two-, three- and four-week, six-month, and one-year, brains to examine.

Ames is planning for two more flights this summer if possible. The launch time depends upon prevailing winds from the launch point at Goosebay to the recovery area near Prince Albert, Canada—about 1900 miles. A requirement is east-west winds which occur for only a few months each year. If the four remaining monkeys in the program don't get off before the time period ends this summer, the flights will be postponed until next year.

• **The package**—Payload package weighs 450 lbs., including four 36-in.-dia. spherical capsules lashed together, with both radio beacon and flashing light beacon for tracking. Monkeys and hamsters are in one capsule, with brain implants to record physiological data during flight. The capsules are light plastic, with no attempt to shield since full exposure is desired.

Monkeys are only part of the experiments on biological systems, providing the brain-effect portion. Other capsules in the same payload contain flour beetles—the most recent flight had some 2000 of these—and seeds, including marigold, African daisy, hybrid corn, and nerve cell tissue. The latest flight had no human tissue.

Other experiments in the recent payload included influenza and Sabin polio viruses to determine whether radiation causes genetic change in viruses, thereby worsening their effect on man.

The balloon is made of polyetgelene, and is 300 ft. in diameter, 384 ft. tall when inflated at altitude. It is tracked continually by a light plane which keeps constant contact while landing, refueling and enroute. The plane controls the balloon electronically. ⌗

Career Positions

FIELD OPERATIONS ENGINEERS



Missile Test Range

The Special Test Vehicle Project Office of the Atlantic Research Corporation has assumed significant new responsibilities and is expanding dynamically.

We now offer outstanding career positions to engineers who are capable of assisting in the establishment and direction of an effective test range operation. More specifically, we seek professional men with experience in one or more of the following areas: operations management, vehicle assembly, instrumentation and tracking, electronic device development, checkout and systems analysis, documentation, quality assurance and reliability.

Some positions are available in the Los Angeles area, others at sites in New Mexico. The assignments call for inventive engineers capable of solving problems under less than ideal conditions.

Financial compensation reflects the importance of the assignment and is worthy of your investigation. Stock options and other attractive benefits.

Send resume to:
Mr. Brooke Bright

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Circle No. 14 on Subscriber Service Card

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AUGUST

Pacific Energy Conversion Conference, American Institute of Electrical Engineers, Fairmont Hotel, San Francisco, Aug. 13-16.

International Science Writers' Seminar, sponsored by the American Institute of Physics with the cooperation of the American Institute of Biological Sciences and American Chemical Society, Seattle, Aug. 13-16.

Seventh Symposium on Ballistic Missile and Space Technology, U.S. Air Force Academy, Colorado Springs, Colo., Aug. 13-16.

Conference on Lunar Exploration, sponsored by National Science Foundation, Langley Research Center of NASA, and Virginia Polytechnic Institute, VPI, Blacksburg, Va., Aug. 13-17.

Cryogenic Engineering Conference, sponsored by ARC, AMS and IAS, U.S. Naval Post Graduate School, Monterey, Calif., Aug. 15-17. (Classified.)

Third International Electronic Circuit Packaging Symposium, University of Colorado, Boulder, Aug. 15-17.

American Society for Quality Control, Joint Western Regional Aircraft and Missiles Conference, Benjamin Franklin Hotel, Seattle, Aug. 16-18.

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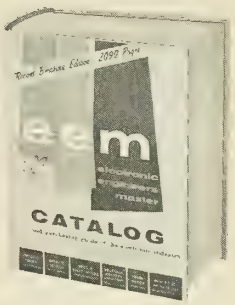
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Vacuums on the AEC

THE APPOINTMENTS of James T. Ramey and John G. Palfrey to the two vacant posts on the Atomic Energy Commission have met with general approval. The two major Washington newspapers greeted the news favorably and sentiment on the Hill was that a suitable compromise had been arranged.

We have nothing against compromise. Without it, government could not function. But in this instance we are not sure the public interest has been served.

The AEC is playing an increasingly more important role in the space field and has, in fact, been termed on occasion "the third space agency." The organization of the AEC is therefore of considerable importance to this industry.

We are not overly impressed with the qualifications of the two appointees. Mr. Ramey, as executive director of the Congressional Joint Committee on Atomic Energy, has been a source of considerable friction between the committee and the AEC. There also are one or two other things in his background which make us wonder about his fitness for such a post.

Mr. Palfrey is a tennis-playing Harvard classmate of President Kennedy. Recently dean of New York's Columbia College, his background in the atomic field has been largely academic, aside from a brief stint on the AEC legal staff.

Mr. Ramey literally was forced upon the administration by the Democrats on the Joint Committee, who refused to consider any other nominees unless Ramey was accepted. The fact that this was public knowledge may lead to some unsavory wrangling when the appointments come before the Senate.

As we have said in the past, however, we do not believe in condemning a man before he has had a chance to prove himself in a new job. It is not really the suitability of the two appointees that concerns us most. It is the suitability of any appointee at all.

For some time now, planning has been under way to abolish the five-man Atomic Energy Commission in favor of a single administrator.

This plan has White House approval and is in full accord with the beliefs of the present members of the AEC, as well as the two members who resigned on July 1, Loren Keith Olson and John S. Graham.

There simply is no longer a need for three commissioners, let alone five. But the switchover cannot be immediately undertaken, since it requires Congressional action.

It seems most inadvisable at this time to expand the commission to its full membership. It would have been far better to have left the two posts vacant.

We realize a political vacancy is an irresistible vacuum. We also know the two new appointees have been warned they may be in for short terms. But it is too much to expect that a brand-new Commissioner will work enthusiastically for abolition of his job.

It also is very unlikely that the two new candidates will do much to reduce the friction that exists between AEC, the Air Force and the National Aeronautics and Space Administration in the field of nuclear space power. It would be much more natural for them to attempt to expand AEC's role in space, particularly if one or the other has his eye on a future administrator's job.

We firmly believe AEC should be in the subordinate position of a service organization in the field of nuclear power for space vehicles. We don't need another competing agency.

Missions and requirements are properly the concern of Air Force and NASA. If AEC is allowed to succeed in its attempt to grab a systems role in auxiliary space power, there is no reason it cannot make the same case for systems engineering of nuclear upper stages or complete nuclear vehicles, ramjet or otherwise.

AEC performance in the past in the APU field has not been one to inspire confidence. Busy with the well-funded aircraft nuclear propulsion program, it declined to properly support Air Force requirements in the *SPUR* program. When *ANP* was cancelled, AEC did a swift about-face.

It insisted there were few important differences in the two fields and, without competitive bidding, awarded Pratt & Whitney a contract for nuclear APU work at the government-owned CANEL facility. There is a strong possibility that competitive bidding would have confirmed P&W as the most competent and desirable contractor.

BUT THE NEGOTIATED procurement left a bad taste in the mouth of contractors who had been working on the Air Force program. Lest anyone think this is just industry pique, it should be noted that the AEC commissioners themselves split in a bitter dispute on this very point.

Pratt & Whitney's position in this is not questioned. But the AEC decision still lacks justification. The interagency dispute still has not been settled. Technical variances already are evident which threaten to slow down nuclear space power development.

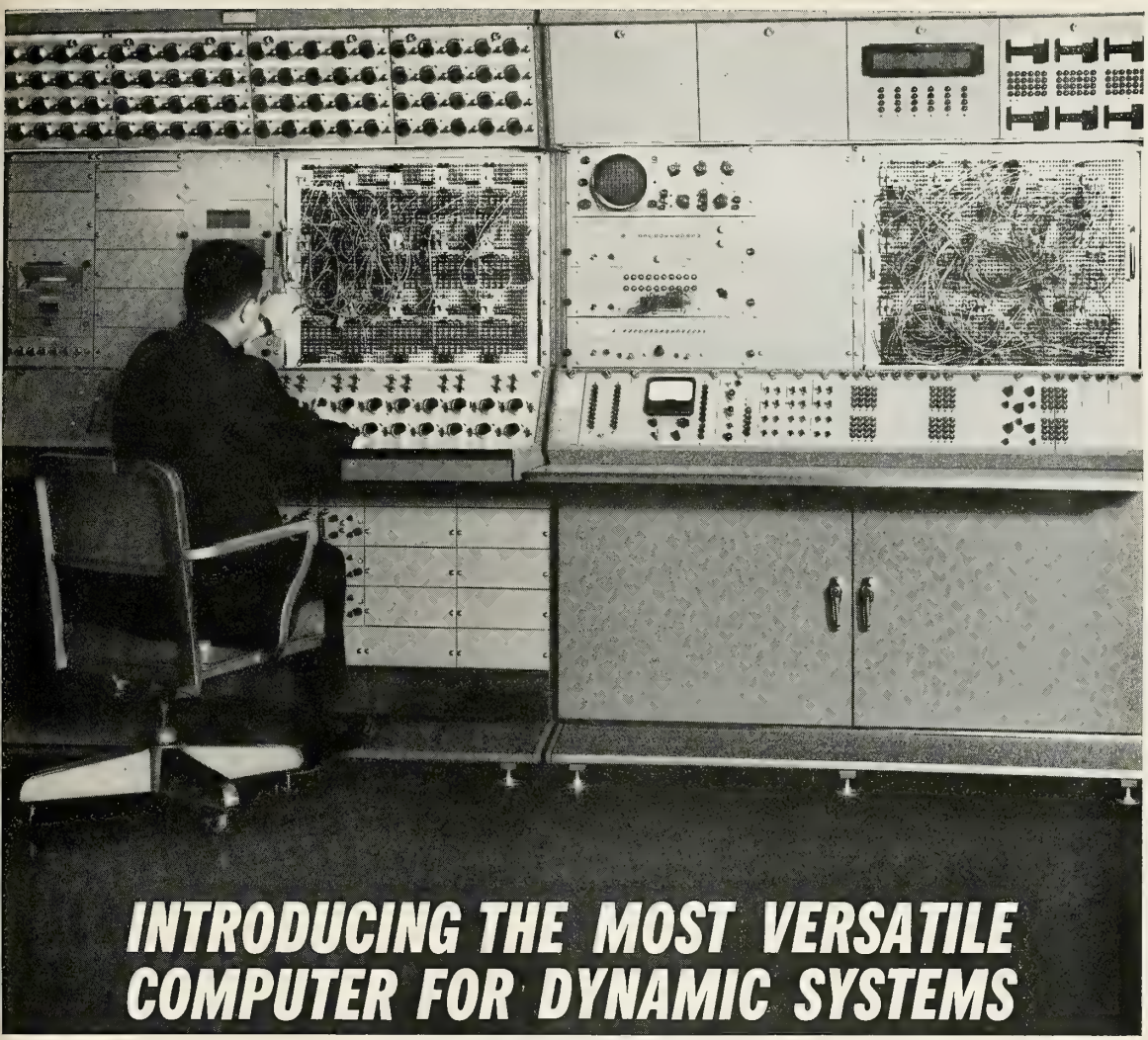
One plan proposed for reorganization of the AEC calls for its division into two agencies. The first would be an Atomic Energy Administration. This would carry out present AEC duties in regard to production, research, reactor development and military application. It would be headed by an administrator.

The second agency would be the Atomic Energy Board. Three members appointed to twelve-year terms by the President would carry out the present quasi-judicial functions of the Commission. Both agencies would be within the executive branch.

Twelve-year terms seem somewhat long, but otherwise this proposal offers a sound basis for AEC reorganization. We hope something of this type will meet with a favorable Congressional reaction. We also hope it will be made clear to the new Administrator and his staff that AEC's role in the space field is strictly limited.

Since the new appointments will tend to become a counter-force to all of this, we regret that the two vacancies were not left vacant—despite the political temptation.

William J. Coughlin



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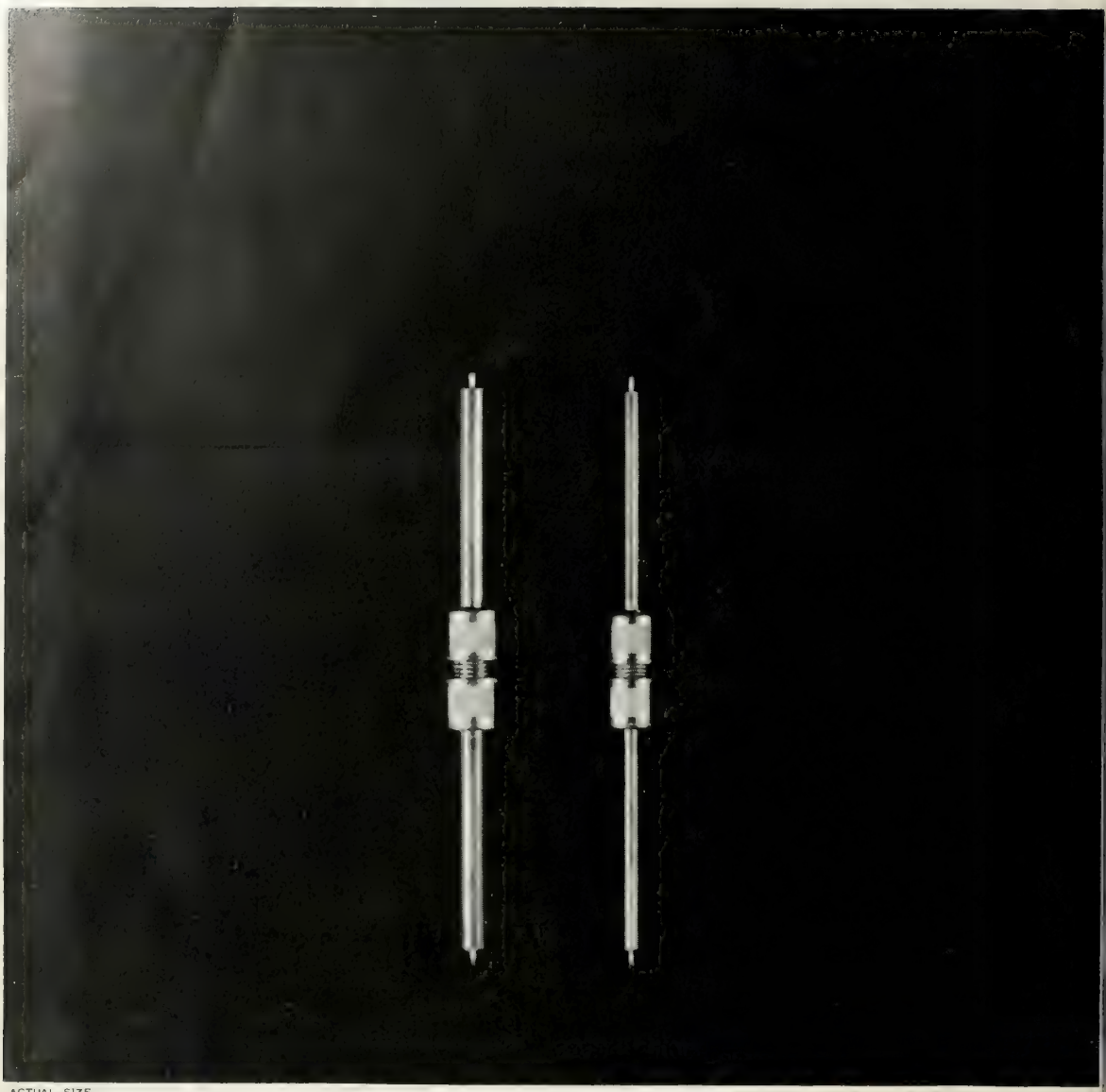
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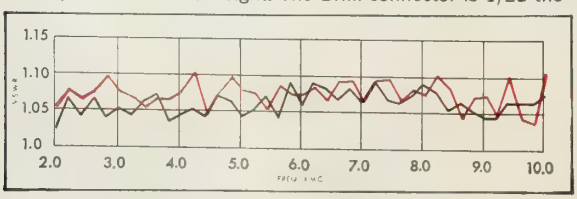
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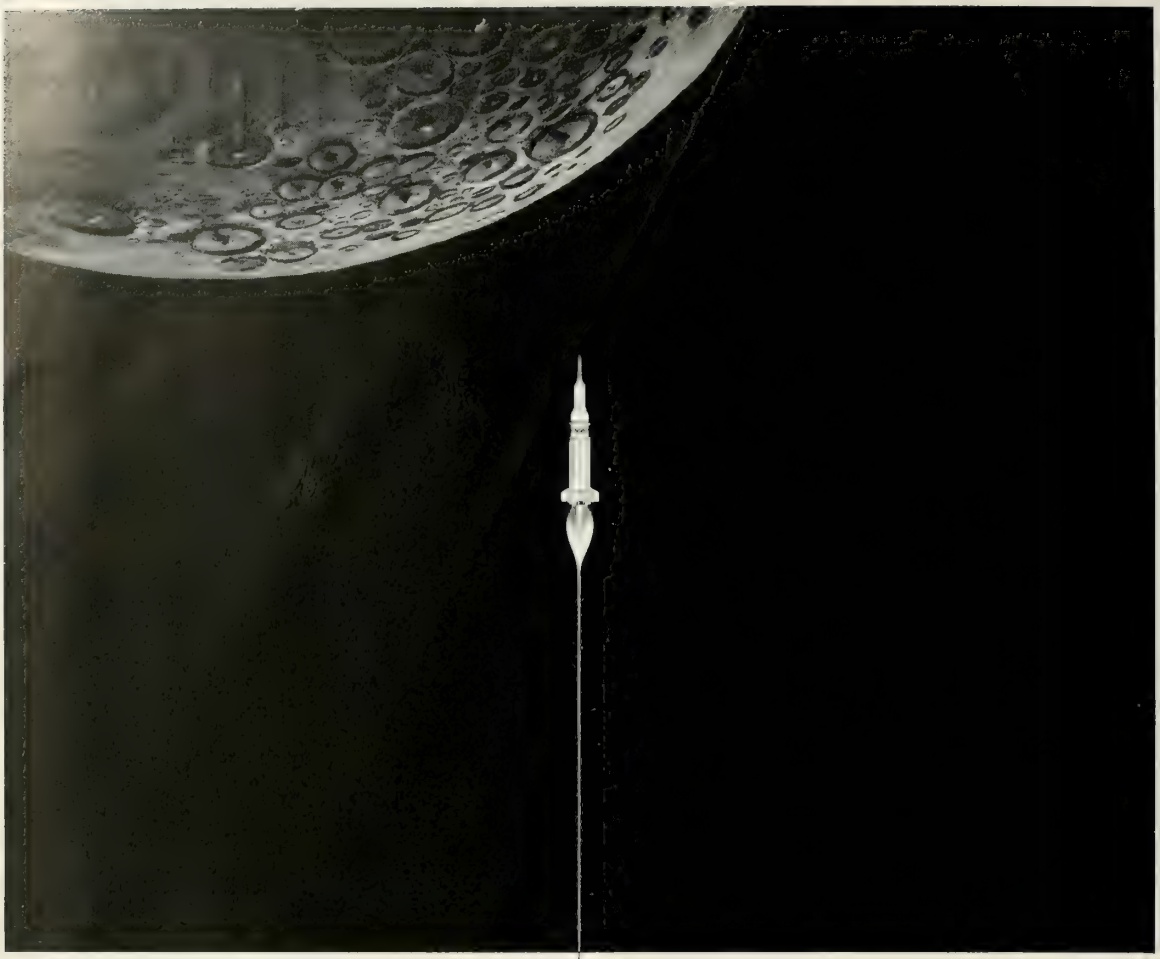


U.S. Plans No 'Crash' Spending to Catch Up With Soviets

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Cosmonauts Nikolayev (top) and Popovich

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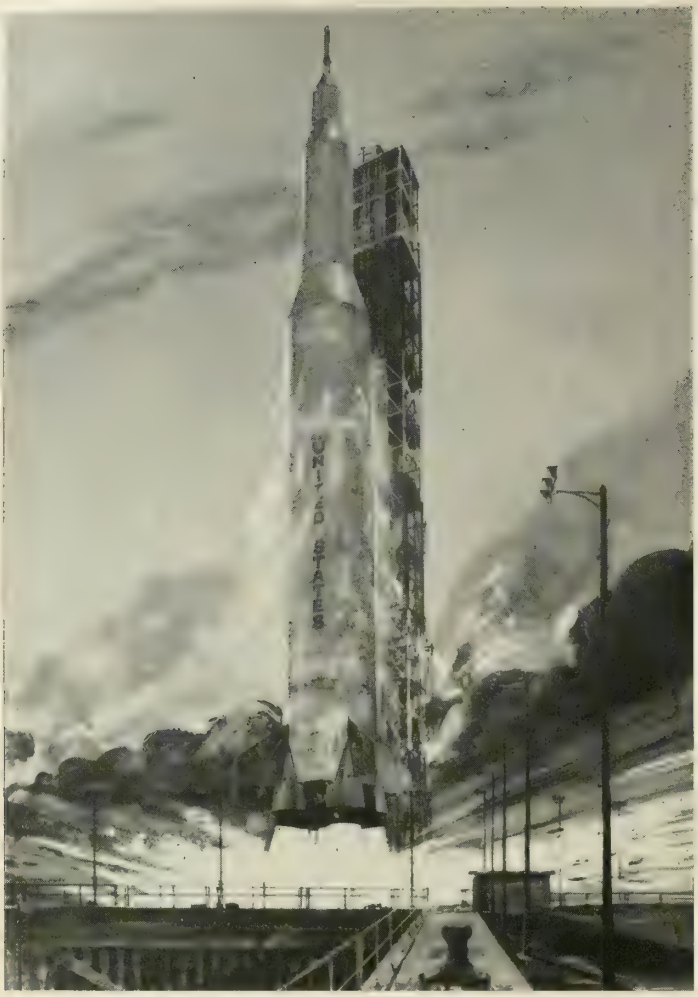
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Volume 11, Number 8, August 20, 1962

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THE COVER

Soviet Maj. Andrian Nikolayev (above) and Lt. Col. Pavel Popovich piloted Vostoks III and IV to a total of more than 112 orbits before landing on Aug. 15. A report on the flight and its implications starts on p. 12.

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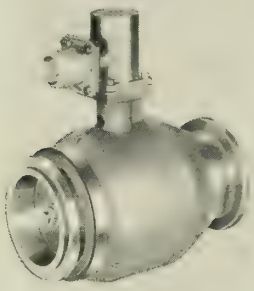
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letters

R&D Salaries

To the Editor:

My attention has been called to your editorial entitled "Curiouser and Curiouser" in the July 9 issue of MISSILES AND ROCKETS, in which you assert that I have suggested placing a "top limit of $25,000" on "salaries in research and development firms which are awarded contracts in non-competitive bidding." That assertion is in error. I have made no such suggestion, nor do I consider that it would be a sensible course to follow.

Had you read either the report to the President on *Government Contracting for Research and Development*, dated April 30, 1962, or my public testimony before the Holifield Subcommittee on June 21, you would be aware that the view of the Administration—which I fully support—is that "where the research and developing contracting system does not provide built-in controls (for example, through adequate competitive bidding . . .), contractors should be reimbursed only for reasonable compensation costs. The basic standard for reimbursement of salaries and related benefits should be one of comparability with the compensation of persons doing similar work in the private economy . . . Where the comparability standard is difficult to develop—say above the $25,000 salary level—salaries should be personally approved by an officer reporting directly to the responsibe agency head." (The quotation is from my statement to the Holifield Subcommittee).

Thus the position of the Administration is that in cost-reimbursement type contracts, the Government should reimburse for salaries comparable to those paid in the private economy, and we explicitly assume that the Government should continue to reimburse for salaries above $25,000 in appropriate cases.

Since your error in reporting my views has caused wide concern and confusion, I would appreciate your printing this letter.

David E. Bell
Director
Bureau of the Budget
Washington

We read the report and we read the testimony. Mr. Bell told the committee that the government should place a limit on salaries for which it would reimburse a contractor. As he notes above, he suggested $25,000 as a level above which salaries would be controlled by an official reporting directly to the head of an agency, such as the Department of Defense. That, in our view, would be a limit whether exceptions were allowed or not. But we do not intend to argue semantics with Mr. Bell. We have our idea of what is going on and he has his. We are delighted to hear that he does not consider such a limit a sensible course to follow.—Ed.

Space-Power Battle

To the Editor:

Thanks to you and Bill Beller for calling attention to the NASA, Air Force, AEC battle which is slowing down nuclear power development. Let's hope Congress pays some attention to your demand in the July 23 editorial for an investigation. A number of firms, including my own, are 100% behind you.

NAME WITHHELD

The Congressional Joint Atomic Energy Committee has announced public hearings on the problem Sept. 5-7 and the House Appropriations Committee has cut the AEC budget in this field by $3.4-million, pending solution (see M/S Week, p. 11).—Ed.

Moon Sampling

To the Editor:

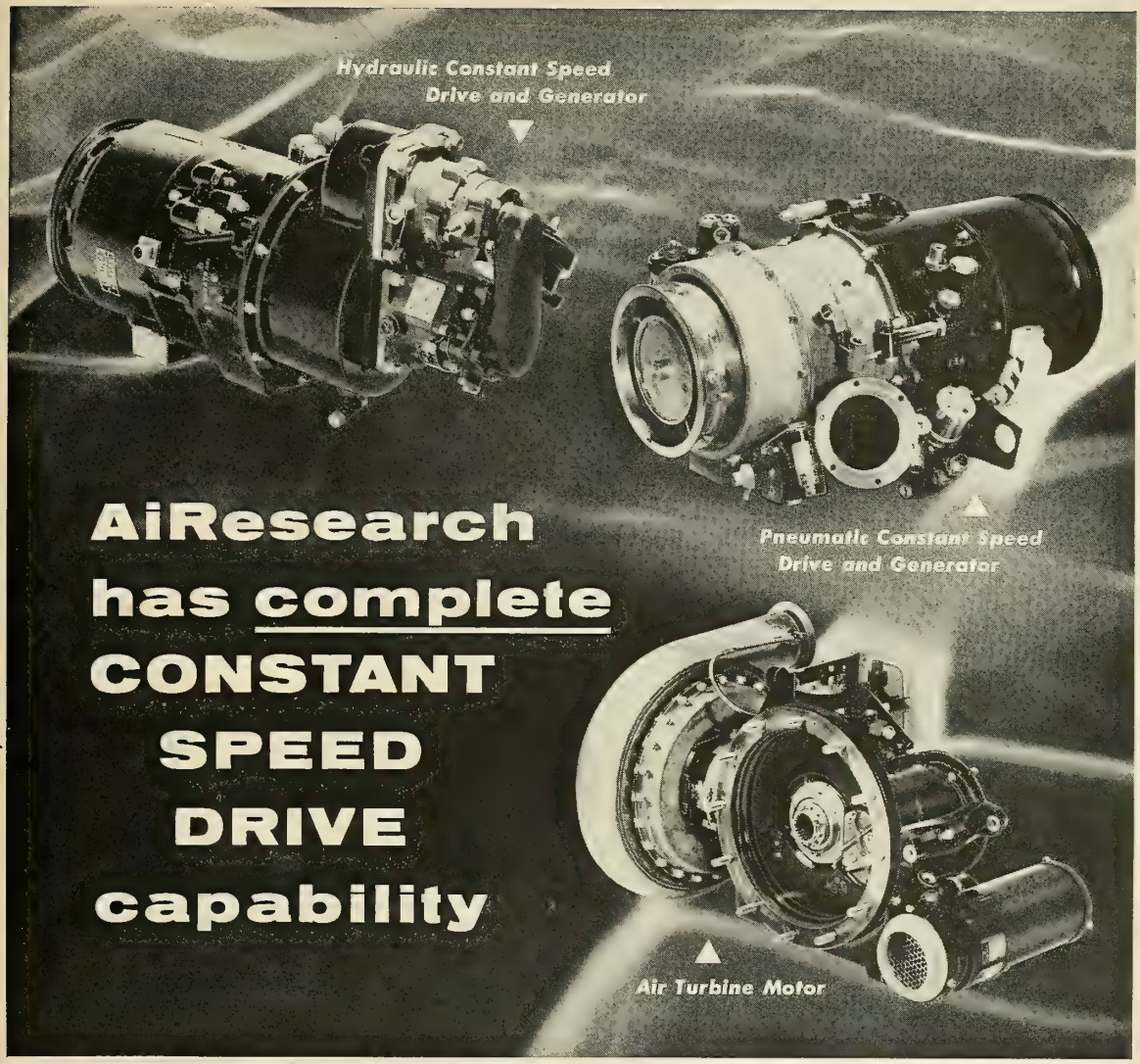
Having a slight knowledge of geological principles, I was interested in Project *Greencheese* as proposed by Sperry Gyroscope (" 'Greencheese' Vehicles Proposed as Moon Samplers," M/R, July 23, p. 22).

The information supplied regarding the prime purpose of the vehicle was sparse and the terminology inaccurate. I reference the statement concerning the high-speed drill for obtaining samples of "hard pan." Hard pan is a farmer's term referring to sedimentary stratas developed by several various means. In any case, the mechanisms involved in producing "hard pan" are dependent on atmospheric agents, namely those producing erosion and chemical changes. This, of course, implies water, and no studies of lunar surfaces have produced evidence of sufficient water to produce erosion and, consequently, sedimentary rocks as we know them on Earth.

In discussion of the drill-type sampling, it appears to me that core samples would afford far more information as to the fabric of the rocks on the Moon. To achieve this, a simple explosive-actuated core sampling device with the core sampling being retracted might be simpler and result in better samples. In addition, deeper penetration can probably be achieved. This would be necessary as the unconsolidated sediments lying on the Moon's surface will probably have a depth of at least one foot.

In addition, if the definition of "hard pan" refers to the hard pans of the Earth, duplication is found in this project: "hard pan" is made up from the unconsolidated sediments lying above it stratigraphically. Therefore, the minerals and/or rocks found in the hard pan will be essentially those that will be recovered by conveyor belt sampling. It would appear advisable then to devise means of obtaining sediment (secondary) and bedrock (primary) samples.

H. M. Sjovold
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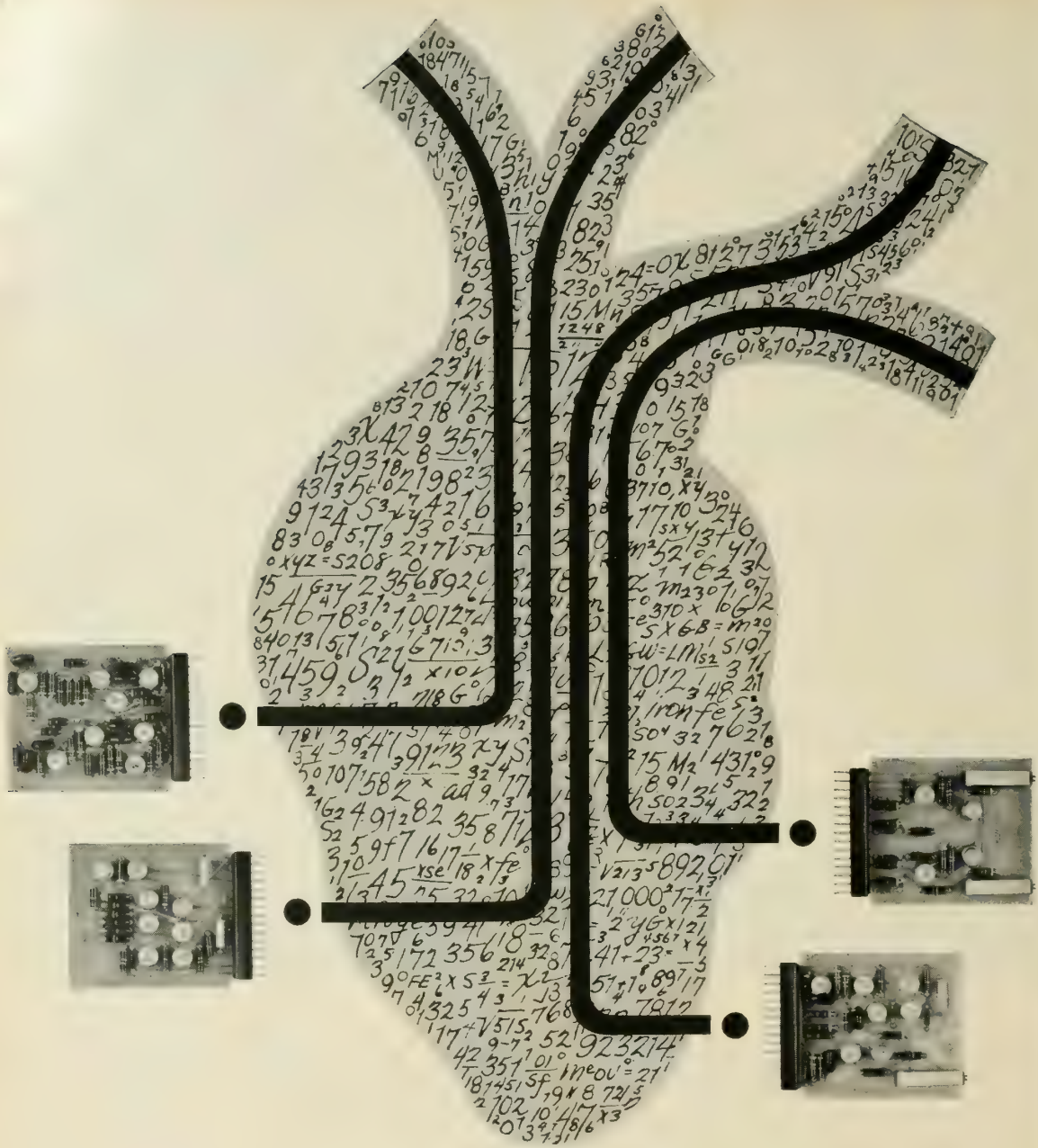
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The Countdown

WASHINGTON

McDonnell Up for Lunar Contract

NASA is considering award of a study contract to McDonnell Aircraft for design of a two-man spacecraft for direct flight to the Moon. No final decision has yet been made and the space agency still may elect to keep the study in-house.

Lewis Awards Ion Contract to Hughes

Hughes Research Laboratories has won a contract from Lewis Research Center for development and fabrication of a cesium ion rocket engine. When completed, the engine will be the first flight-test ion engine developed by NASA.

AF May Lease Telstar Circuits

Air Force is considering lease of one or more circuits of AT&T's *Telstar* satellite in order to obtain early operational experience with communications satellites.

Nike-Zeus Fate is Considered

A DOD spokesman declined to state specifically that the fate of *Nike-Zeus* was a topic for last week's high-level Colorado Springs session attended by Defense Secretary McNamara and other top Pentagon brass. He did acknowledge, however, that the group reviewed NORAD's Fiscal '64 budget requirements, including air defense missiles.

NASA Centaur Report Further Delayed

NASA's report to Congress on the lagging *Centaur* program has been delayed until the end of August. Space agency officials—charged with getting the report to the House Space Committee—will give no reason for the delay except to say their review of the program is not complete. Report initially was due Aug. 1, then slipped to Aug. 13 (M/R, Aug. 6, p. 9).

House to Probe Weather Satellites

House Space Committee is scheduled to hold public hearings this week on the U.S. weather satellite programs. NASA and Weather Bureau officials are to testify during the Aug. 21-23 hearings.

Advent Direction Still Uncertain

Last week's Congressional hearings made it plain that direction of the *Advent* program still is suffering for lack of an overall manager. Military officials admitted some $76 million has been irrevocably lost on the program already.

DOD Press Policies Growing Worse?

Pentagon newsmen are becoming increasingly irked with DOD press policy. One and a half hours after news of *Missile B* contract awards was announced by senators and congressmen last week, a reporter who called the Pentagon for information on the program was told: "I can't talk to you on it for another 2½ hrs." Reason: Administration policy is to give the Hill a four-hour headstart.

INDUSTRY

Astronaut Interest in Fairchild

Possibility of the U.S. astronauts investing in Fairchild Stratos Corp. was subject of a heated argument at the firm's last board meetings between astronaut business manager Leo C. DeOrsey and at least one board member. DeOrsey is a member of the Fairchild board. Top management sentiment is split over the idea.

Lockheed Moving on 156-in. Study

Lockheed Propulsion Co. is going ahead with a program to test 156-in. nozzles on its 120-in. solid booster. Hope is to get a jump on the forthcoming 156-in. competition. But at least one other company in the field may start on a full 156-in. booster with its own funds. Key to this is the fact that present facilities can accommodate the 156-in. booster.

Marquardt Sees Ramjet Space Market

President Roy E. Marquardt of Marquardt Corp., longtime advocate of ramjets, foresees a major swing to the use of rocket-ramjet engine systems for future missile/space propulsion needs. He told the New York Society of Security Analysts that large chemical rocket boosters are reaching a performance potential ceiling. Firm's projection is for $60 million in sales in 1963 on this basis—a substantial increase on its predicted 1962 year-end sales of $54 million.

Martin and GD Nova Awards Signed

NASA non-profit contracts for detailed system definition and preliminary design of the *Nova* space booster were signed at Marshall Space Flight Center last week. Contracts are for almost $1 million each and the companies are expected to finance part of the work. The studies will run through May 16, 1963.

Edwards to Get Jet Space Simulators

Three Lockheed F-104's augmented with 6000-lb.-thrust Rocketdyne liquid rocket engines and equipped with Minneapolis-Honeywell *X-15* reaction controls are to be delivered to Edwards AFB next year for use as space flight simulators. The Aerospace Research Pilots School also will get two Convair F-106B's and a McDonnell F-101 with the adaptive flight controls for the same purpose. F-101, which was equipped with the system for *X-15* prototype testing, is due for October delivery.

INTERNATIONAL

Five-nation Production for Bullpup

Five NATO nations, including the U.S., will join in Martin *Bullpup* production in Europe. Great Britain, Denmark and Turkey will participate in the program, in addition to Norway, which signed a licensing agreement last April for production at Kongsberg Vapenfabrikk.

All-Canadian Satellite Due

Launch of *Alouette*—Canada's S-27 Topside Sounder—is scheduled from the NASA *Thor* pad at Vandenberg AFB next month. If successful, it will be the first satellite in orbit to be built entirely by a nation other than the U.S. or USSR. Much of the work on Britain's *UK-1* was done at Goddard Space Flight Center.

RFI PROBLEMS CALL FOR SERVICE BY SPECIALISTS

As a basic threat to electronic equipment performance and reliability, Radio Frequency Interference commands major concern today. No longer regarded as merely a nuisance, its often costly, sometimes tragic consequences underscore the need for effective control methods: A missile launching is ruined by premature triggering of electro-explosives . . . a plane's safety is threatened when interference critically disrupts communications . . . errors are caused, impairing computer calculations.



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The Missile/Space Week

Shots of the Week

Two Russian cosmonauts, Maj. Andrian Nikolayev and Lt. Col. Pavel Popovich, commanded the world's attention with their record-shattering orbital flights which began Aug. 11 and 12, respectively, and concluded Aug. 15 (see p. 12).

Other shots in a busy week:

• On Aug. 9 an advanced Boeing *Minuteman* broke in two shortly after being launched from a Cape Canaveral silo. It was the second failure in two attempts for the Wing II version of the missile, and prompted a re-evaluation of the first stage.

• A NASA sounding rocket carrying a 258-lb. payload climbed from Wallops Island, Va., to 92 miles Aug. 9, but the payload was lost in the Atlantic after a 10-min. flight.

• A SAC missile combat crew launched two General Dynamics/Astronautics *Atlas* missiles in quick succession Aug. 9 from Vandenberg AFB, Calif. The AF said only that the launches proved multiple countdown capability.

• An advanced *Atlas F* was intentionally destroyed Aug. 10 after being elevated from its silo and launched from Vandenberg AFB. Cause of its malfunction was not announced.

• A modified Lockheed *Polaris A2* traveled 1700 miles into the Atlantic Missile Range target area after being launched from Cape Canaveral Aug. 10. The missile carried components being tested for the advanced *Polaris A3;* the Navy said its flight was successful in all respects.

• A Boeing *Bomarc-B* missile successfully intercepted a *QF-104* over the Eglin AFB (Fla.) Gulf Range Aug. 10 even though the drone was put through evasive action. The strike came 234 miles down-range.

• Sweden and the U.S. scored their second straight success Aug. 11 when a two-stage *Nike-Cajun* went up 24 miles over Sweden to gather data on bright night clouds and the Northern Lights. The first flight took place Aug. 7.

• An *Atlas F* carrying a scientific experiment "met all its test objectives," the Air Force said, in an Aug. 13 launch from Cape Canaveral. The missile tested a method for producing oxygen for astronauts on long space flights.

• NASA test pilot Joseph Walker made a troublesome but successful *X-15* flight Aug. 14. His mission was to test whether the North American Aviation craft's pitch angle indicator could substitute for the angle-of-attack indicator, which gave Maj. Robert White trouble on his record-setting July 17 flight. Walker, satisfied that the pitch angle indicator could substitute during re-entry, then had to wrestle with the craft to correct rolling and yawing after its automatic roll damper failed. Walker's top speed was 3784 mph.

Agena D Launches Revealed

The Air Force has successfully flight-tested the Lockheed *Agena D* standardized upper-stage vehicles, Under Secretary of the Air Force Joseph V. Charyk told the Seventh Symposium on Ballistic Missile and Space Technology last week.

The first firing took place in June. Since then there has been one more flight test of the vehicle. Both have been successful.

Agena D differs from the *A* and *B* models in that the latter had integrated payloads whereas the *D* model can accept a variety of payloads.

Launchings have been from Pt. Arguello, Calif.

AF Balks at Joint ComSat

A House Space Subcommittee last week touched off a possible congressional drive to combine the communications satellite programs of the Defense Department and NASA.

Subcommittee Chairman Joseph Karth (D-Minn.) said he was convinced that research effort was being squandered in developing two separate systems.

Gen. Bernard Schriever, head of the AF Systems Command, promptly replied that military use of commercial facilities "clearly would be extremely difficult in some cases and impossible in others."

DOD Approves Titan III

Total awards in the *Titan III* program approved by Department of Defense are expected to exceed more than $800 million over the next five years and eventually top a billion dollars.

Defense Secretary McNamara signed a *624A* launch vehicle program last week which will provide the Air Force with a standard launch vehicle for at least a ten-year period.

The booster, with 2.5 million lbs. thrust, is made up of a modified Martin *Titan II* ICBM, two United Technology Corp. 120-in. solid boosters and an Aerojet-General transtage propulsion unit.

Martin Co. will develop a new upper stage for *Titan II*, in addition to its responsibility for assembly, test and systems integration.

Although payload capability was announced as 5000 to 25,000 lbs. in orbit, it is expected to reach 30,000 lbs. *Titan III* will be employed in the *X-20*, *Gemini* and *Saint* programs in addition to others.

Three To Design New OSO's

NASA has awarded three study contracts for design of a series of advanced *OSO* (Orbiting Solar Observatory) spacecraft.

The three-month contracts, each for $100,000, went to Ball Brothers Research Corp., Republic Aviation Corp., and Space Technology Laboratories, Inc. Ball Brothers is prime contractor for the present *OSO* series, the first of which—*OSO I*—is now in orbit.

AEC Funds Cut, Hearings Set

The House Appropriations Committee last week slashed $3.4 million from the Atomic Energy Commission's budget for nuclear space power development.

At the same time the Congressional Joint Atomic Energy Committee announced it will hold public hearings Sept. 5-7 to take a critical look at the nation's nuclear space power programs —with emphasis on the long-drawn-out dispute over control of the joint Air Force-AEC *SPUR-SNAP 50* program (M/R, July 23, p. 12).

The Appropriations group noted its displeasure over lack of progress in achieving AF-NASA-AEC agreement on which agency is to develop conversion equipment for *SNAP* units. Then it cut $3,417,000 from the amount requested in AEC's Fiscal 1963 budget for the advanced space power system portion of the satellite and small power sources program.

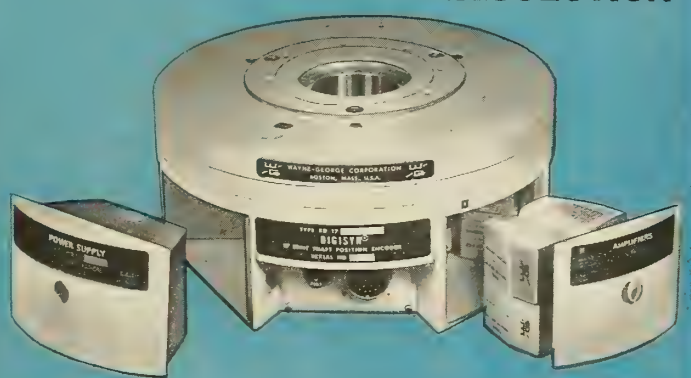
ComSat Bill Nears Vote

The Senate late last week neared a vote on the communications satellite bill after invoking the first cloture since 1927. The cloture passed 63 to 27 Tuesday, limiting debate on the bill to one hour per senator, and immediately triggered a round of amendments proposed by the bill's opponents.

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Despite Vostok successes . . .

U.S. Plans no 'Crash' Spending

Top NASA, DOD officials see no advantage in accelerating expenditure; hopes pinned to big boosters; AF may gain funds

by Hal Taylor

TOP U.S. OFFICIALS have ruled out any crash spending program to cope with the new evidence of Soviet space leadership.

This was made clear shortly after two Russian cosmonauts were returned safely to Earth following twin orbital flights of over 64 and 48 orbits in two separate spacecraft.

Cosmonaut Maj. Andrian Nikolayev set a new space endurance record in *Vostok III*. Launched on Aug. 11, he orbited the Earth over 64 times as he traveled a distance of 1,615,600 miles.

On Aug. 12, Cosmonaut Lt. Col. Pavel Popovich was launched in *Vostok IV*. He orbited the Earth more than 48 times in a 1,243,000-mile flight.

Both landed safely within six minutes of each other on Aug. 15.

Reacting to the flight, top White House, NASA and DOD officials asserted their stand-pat position despite the fact that the flights demonstrated the Russians may be close to achieving manned Earth rendezvous capability and multi-crew flights.

One positive reaction, however, could be easier sailing for the Air Force in getting approval for a large military space mission. This could result in increasing spending, possibly as early as Fiscal '64.

While congratulating the Soviet Union on the space feat, U.S. officials maintained there was nothing unexpected in the Russian performance.

NASA Administrator James E. Webb declared that the flight "has not changed my mind about the correctness of our current rate of spending." He said that increased spending on Project *Apollo* might cut into the funds available for military programs.

"I still think we will put a man on the Moon and return him before the Russians," Webb said.

Deputy Administrator Dr. Hugh L. Dryden told MISSILES AND ROCKETS that it is "difficult to see how increased spending could speed up the program." This, he said, is primarily because of the long lead times involved in large launch vehicle and spacecraft programs.

His opposition was buttressed by D. Brainerd Holmes, director of the Office of the Manned Space Flight, who said that a crash program would only cut six months to a year from the development of the *Advanced Saturn*. "A crash program," he continued, "is not necessarily a better program."

Dr. Edward C. Welsh, executive secretary of the National Space Council, told M/R the Russian flights "are not significant enough for us to change anything."

He said the U.S. space program is already being speeded up through increased spending. He pointed out that NASA's budget will jump from about $3.7 billion in Fiscal '63 to about $5 billion in Fiscal '64.

The Administration official indicated, however, that the Soviet flights could have a positive effect on the U.S. military space program. "It may alert some people who have been hesitant about the military aspects of space," Welsh said.

This was only partially supported by the ranking DOD official to comment publicly.

The dual manned orbit success of the Russians is not likely to have any "surge" effect upon U.S. military space programs, Deputy Secretary of Defense Roswell L. Gilpatric declared. He acknowledged that existing programs might be re-examined.

"But, at the moment, I do not see any change in program weight or emphasis," he said. Gilpatric insisted that the U.S. still has a "jump on the Russians," and said the U.S. has the "talent to pick up momentum if needed."

• **Big booster faith**—The optimism of U.S. space agency officials is based on belief that the U.S. is on an equal footing with the Russians in development of the giant boosters for the manned lunar landing mission.

Soviet writer tells how Vostoks are superior to Mercury—See Soviet Affairs, p. 40.

Dr. Dryden said NASA has been waiting for the Russians to come up with a big booster ever since the space agency was formed. "Instead, to the best of our knowledge, they have been developing lighter nuclear payloads and missiles," he said.

Webb added that while NASA has no definite information on the status of the Soviet big booster, "we have reason to believe they are not devoting as much resources to their program as we are to ours."

While the big booster argument may have some validity, there were other aspects of the flights which indicated Soviet leadership in certain areas of peaceful and especially military uses of space.

DOD—with the exception of the Gilpatric statement—refused to comment.

• **Red gains** — Several impressive achievements were compiled by the Russian flights:

—The launchings of the two spacecraft into similar orbits on two separate days required immense launch and tracking capabilities. Experts estimated that Soviet technicians had only a timespan of seconds to get the second launch off.

U.S. officials admitted that this was an "achievement", but that the same technology had been demonstrated in the two American Project *Mercury* launches. They pointed out that the orbits of Astronauts John Glenn and Scott Carpenter were almost identical.

It should be noted that such flights are not possible in the *Mercury* program, simply because only one launch pad is available. It takes a minimum of six weeks to clear the pad for another launch. While another *Atlas* pad at Cape Canaveral could be modified for *Mercury*, this would take months.

Such flights will not even be possible in NASA's Project *Gemini* series, which currently calls for only one manned spacecraft in its rendezvous experiments.

—The flight demonstrated that the Russians have developed the beginning

technology necessary for achieving Earth orbit rendezvous. According to various reports, the spacecraft at one point were within six miles of each other. Later, the distance lengthened considerably. Dr. Dryden declared that the Russian flight was only the first step in rendezvous. "A lot more is required than simply launching vehicles into similar orbits," he said. Space experts noted, however, that it was quite possible that the spacecraft have the onboard propulsion required for rendezvous docking operations. This was confirmed in part by Soviet announcements noting that the flights were the first step in the eventual building of space stations in Earth orbit.

The U.S. *Gemini* program will not accomplish similar rendezvous flights until mid-to-late 1964.

—The twin Soviet satellites orbiting within sight of each other have already accomplished more than DOD's *Saint I Satellite Inspector* program. The U.S. program is behind schedule and the first launching still has not taken place. *Saint I* would be an unmanned system. *Saint II* would be a manned satellite interceptor system. No study or development contracts have been awarded. The flights of *Vostok III* and *IV* clearly demonstrated the feasibility of a manned satellite destroyer. They have also already accomplished one of the objectives of the *Saint I* system—the transmission of space-to-Earth television pictures.

—The Soviet capability of orbiting two or more manned spacecraft for long periods of time gives them a reconnaissance potential far higher than DOD's heralded unmanned *SAMOS* and *MIDAS* programs.

—The flights clearly demonstrated that the Soviets are well on the way to development of both manned and unmanned orbital weapons systems.

The apprehension over the military aspects of the flight was supported by Sir Bernard Lovell, head of Britain's Jodrell Bank Radio Telescope.

He declared that the Soviet Union soon should be able to destroy American satellites in space.

The latest Russian flights, he said, show that the Soviets "have clear space superiority in the military, if not in the scientific sense."

"I can see no reason at all," he continued, "why the Soviet Union should not now very quickly be in a position to dispatch the U.S. *MIDAS* spy satellites."

While the world was still reacting to the latest flights, Soviet space scientists were already predicting new flights in the near future. These, they said, would not only be multi-man flights for longer than the current record four days, but they also would lead to the building of space stations in Earth orbit.

• **Russian harvest**—The twin orbital flights by Nikolayev and Popovich apparently provided valuable data on space rendezvous techniques and the long-term effects of weightlessness on man.

They likewise afforded impressive evidence of the feasibility of space-Earth television, inter-spacecraft communications, and coordination of action by space pilots.

Placing of Popovich's *Vostok IV* into an orbit nearly identical with that of *Vostok III* also was a powerful demonstration of the Russians' highly accurate tracking and launching techniques.

Unofficial records showed that Nikolayev and Popovich far eclipsed previous space flight marks set by Gherman S. Titov in *Vostok II* Aug. 6, 1961. Nikolayev, launched Aug. 11 aboard *Vostok III*, orbited the Earth more than 64 times and traveled some 1,615,600 miles in just under four days. Popovich, in *Vostok IV*, completed more than 48 orbits and traveled about 1,243,000 miles during its trip of almost three days.

Titov, by comparison, orbited Earth 17 times and covered 437,500 miles in 25 hours and 18 minutes. Lt. Cmdr. M. Scott Carpenter and Lt. Col. John H. Glenn made only three orbits of the Earth.

• **Nikolayev first** — Reportedly launched from the main Soviet "spaceport" at Baikonur, not far from the Aral Sea, Maj. Nikolayev was put into a low Earth orbit at 11:30 a.m. EDT Aug. 11. His *Vostok III* achieved an apogee of 141.3 mi. and a perigee of 109.7 miles. The spacecraft was launched at an angle of inclination of 64.59 degrees to the equator and circled the Earth every 88.2 min.

At 11:02 a.m. Aug. 12, *Vostok IV* was hurled into a similar orbit with Popovich aboard. Its apogee was 145.8 mi.; its perigee, 110.5 mi. The angle of inclination and period of *Vostok IV* were 64.57 degrees and 88.3 minutes, respectively.

Significantly omitted from the launch data, however, were the weights of both craft. *Vostok I* and *II* had announced weights of slightly over 10,400 lbs. Exclusion of weight data for the latest craft led to speculation that they were heavier than either Gagarin or Titov's capsules. One Communist source—the Danish newspaper *Land Og Folk*—said that the spaceships each weighed 17,000 lbs. However, no source was given for the comment and it could not be verified.

For the first time, the Soviet Union did announce where the cosmonauts had landed. According to Tass, the Soviet news agency, both men landed in the region south of Karaganda—a town in Kazakhstan—some 373 miles northeast of Baikonur.

The cosmonauts landed, according to Tass, within six minutes of each other "according to plan." "Both Cosmonauts are feeling fine," the news agency said.

• **Flight missions**—One of the major missions of *Vostok III* and *IV*, Moscow Radio said, was "to obtain experimental data on the possibility of establishing contacts between two ships, coordinating the actions of the pilot-cosmonauts and to check the influence of identical conditions of space flight on human beings."

(Continued on page 41)

	PILOT	SPACECRAFT	DATE	NUMBER OF ORBITS	TOTAL FLIGHT TIME	ORBITAL PERIGEE (MILES)	ORBITAL APOGEE (MILES)	VELOCITY (MPH)	TOTAL DISTANCE (MILES)	WEIGHT-LESSNESS PERIOD	SPACE-CRAFT WEIGHT (LBS.)
USSR	Gagarin	Vostok I	April 12, 1961	1	108 min.	109	188	17,400	25,000	1 hr. 29 min.	10,460
USSR	Titov	Vostok II	Aug. 6, 1961	17	25 hrs. 18 min.	111	160	17,750	437,500	25 hrs.	10,430
US	Glenn	Friendship VII	Feb. 20, 1962	3	4 hrs. 56 min.	99	162	17,545	81,000	4 hrs. 40 min.	4,200
US	Carpenter	Aurora VII	May 24, 1962	3	4 hrs. 56 min.	99	167.4	17,532	About 81,200	4 hrs. 40 min.	4,200
USSR	Nikolayev	Vostok III	Aug. 11, 1962	64+	Just under 4 days	109.7	141.3	—	1,615,600	—	—
USSR	Popovich	Vostok IV	Aug. 12, 1962	48+	Just under 3 days	110.5	145.8	—	1,243,000	—	—

How the Cosmonauts Were Trained

by Colonel Yevgeni Petrov
Commander, Soviet Cosmonaut Group



COSMONAUTS Nikolayev (at left) and Popovich shown wrestling during training.

IN CHOOSING our candidates we paid primary attention to spiritual and ethical qualities, ideological views and social attitudes. If a man fell short in the basic attributes, he could not hope to come through the many tests space flight would put him to.

It was highly conscious judgment and not blind, automatic reaction that would be required of a cosmonaut. He would obviously have to have good muscles and a strong, steady heart, be in tiptop shape generally. But "tiptop" is a flexible word, and even as between one fighter pilot and another, the choice would have to be very fine.

One air base commander gave us a list of his ten likeliest candidates, with the comment: "You'll find each one better than the last." At first glance they seemed a splendid lot of men for the job, but a closer look showed that only five of them came up to our medical specifications. We hated to disappoint these fine young men, but what could we do? Requirements were requirements.

The full appraisal of the candidates came somewhat later in Moscow, and a very rigorous appraisal it was. The slightest aberration or, as Yuri Gagarin once put it, "the slightest scratch" put a man out of the running. The final set of tests was run on special equipment. The flyers were generally familiar with compression chambers and centrifuges, but this was something new and much more taxing than anything they had gone through at their own posts. The elimination process began all over again. One flyer fainted, another vomited. In these cases, all further tests were ruled out.

• **Toughening up**—We began with physical training. Not all the flyers understood why. Some were puzzled, even irritated. Why all the suddenly intensified setting-up exercises every morning and all the gymnastics and track-and-field work? And why so much less attention to the centrifuges, vibrostands and other special equipment?

There were, inevitably, constant checkups and eliminations. "They can't be avoided," the doctors patiently explained. But the grumblers were not convinced. The medics, they felt, were out to cook up some nonexistent defects.

Take Gherman Titov, for example. He would hear the doctors out, then often do things his own way or ignore their instructions altogether. When they insisted that he follow instructions, Gherman became irritated. But they would not give an inch. They argued with him calmly, even with a little humor. "No one takes medicine because he likes it. The best medicine for you is athletics."

Gherman agreed, but he felt imposed upon by what he considered unnecessary medical supervision of his training and personal life, limitations on his freedom.

But then he underwent a change. It had nothing to do with his mood and spirit, although they had risen a couple of degrees. There was something else that surprised him—he felt stronger. He seemed to weigh less, he walked and ran much more easily.

Not all cosmonauts were in perfect shape when we began their physical training. A bit of running or volleyball tired some of the men very quickly. They complained of muscle pains. But they were soothed by the physical training instructor. "Don't worry about it," he said. "In a short while you won't know yourselves." And one of the doctors added, "Just note down your present blood pressure and pulse. You'll find it interesting to make comparisons after a while."

The suggestions were duly followed. In a month their pulse rates had slowed down, even though they were exercising harder. They began to look upon the doctor as an older comrade, a well-wishing friend or, what was more to the point, an experienced athletic coach.

• **The builders**—A foreign correspondent once asked Gherman Titov, "What helped you to fly around the earth 17 times?" The cosmonaut replied with his usual quick humor, "My ship." Everybody laughed of course, but the answer was not altogether a joke. The cosmonaut never made a truer statement.

For all the words spoken and written about the first men in outer space and all the laurels they were crowned with, the miracle was not theirs alone. A large share came from the men who built the spaceship.

We met these men in the course of our work. We had the same cares and a common aim. The spaceship designer called on us soon after we had begun preparing the cosmonauts. A slow-moving, heavy-set man with a pleasant face and wise eyes with a mischievous twinkle, he was in fine spirits. "I've decided to drop in on you, as you see," he said.

But, of course, he had not come for rest or quiet. He set off at once on a tour of inspection of the laboratories and classrooms.

"Not bad for the time being," he concluded, and then added quickly, "but only for the time being. You ought to lay out new laboratories and install the latest equipment. There'll be little progress without that. Please work up a draft for a new building. Jot down all

the things you need and send me the list."

The inspection was still on when an Air Force car pulled up. A general came out, and the spaceship designer hurried over with the pleased exclamation, "What luck you've come just at this moment!"

His talk with the general was brief but memorable. With his customary frankness, he gave the general his impression of our work, complained of delays in urgent matters and then demanded, "Why don't you say something, friend? Somebody got your tongue? Aren't you interested in our new models?"

"Why yes," said the general unperturbed. "I'll be glad to see the surprises you've got for us."

"I'd rather you came as a helpmate than as a visitor. Aviation, after all, is a relative of space travel."

"You could even say that aviation is the mother of space travel," countered the general. "All these eagles came here from our fighter groups."

"Well, they're not the only ones who came from the Air Corps. I also took my first flight from your nest," the space designer said. "Twenty-five years of my life went into aviation."

When we visited the plant, we were welcomed by the spaceship designer himself. He greeted us like old friends and got down to practical talk. "I want you to get used to your new home. It's right there, in the next room. One of you will man it." Then with a smile, "It may be Yuri or Comrade Titov." We were surprised and pleased that he remembered our names.

He mentioned a date. The boys could hardly believe the flight was so close. Who was going to be the lucky first?

• **Yuri lectures**—The cosmonauts worked tirelessly to familiarize themselves with the ship. After a lengthy discussion one day the designer said, "It's time we began to test you. We'll invite a board of examiners to see what you've learned. Agreed?"

Soon afterward the whole group gathered at the plant, everyone on time and with the old school pre-exam fever. The board of examiners was late. To relieve the tension Yuri Gagarin suggested, "Why waste time? Suppose I talk, and you correct me if I'm wrong."

He took the seat in the spaceship cabin and began a recital of the *Vostok's* construction, its equipment, and the conditions a pilot would be meeting in orbit. He was nearing the end of his recital when the examiners arrived.

Chief Air Marshal Konstantin Vershinin approached the cabin, followed by the board members. "What are you doing," he asked, "reviewing your studies or lecturing?"

"Both, Comrade Chief Air Marshal!" Gagarin answered smartly.

"If that's so, let's begin at the lecture end," said the Marshal smiling, "if you have no objection, Comrade Gagarin." It became so quiet that we could hear the clock in the cabin ticking.

Yuri gathered his thoughts and began, "The Soviet cosmic sputnik ship *Vostok* is designed for orbital flight. . . ."

• **Diving and jumping** — After a couple of months our cosmonauts were ready to admit that the athletic training was indispensable; they felt stronger and had much more endurance. The program expanded when our sports field and outdoor gym were equipped with jumping nets of the kind circus acrobats use for their incredible stunts. In a few weeks the men were doing some very complicated exercises on these trampolins, not up to circus standards perhaps, but their performance was neat, bold and certain.

High-diving from a platform and springboard was an important unit in the training program. The first lesson made it evident that none of them really knew how to dive. The instructor had to do yeomen work before he got the first man to jump from the diving tower.

Nor were our cosmonauts enthusiastic about parachute jumping. Like most flyers, they were accustomed to carrying the item as standard equipment, but they hated to have to use it. The first jumps, as expected, were the hardest.

The group spent several weeks at a distant airfield in the steppes and did several jumps a day. Those who made good progress were soon permitted to bail out over water. That needed special training for a good landing. Our para-cosmonauts had to learn to get out of their straps and part with the chutes a dozen or so yards above the surface and then dive headfirst into the water.

• **"Charged with energy"** — One piece of equipment we use is called a "running path." The cosmonaut in training steps onto a belt that begins to speed up under his feet. He runs faster and faster to keep from being thrown off the path. The pace is regulated from a control panel operated by an engineer and a doctor. Since the trainee wears numerous indicators, the pair at the control panel have a constant check on his physical condition and can adjust the speed to conform.

"Where did you pick up that charge of energy?" someone asked Grigori when he got off the belt. The phrase was apt, our trainees were charged with energy in both the literal and figurative sense. Running, athletics, high diving, swimming, flying, parachuting and this "running path" all gave the added speed, endurance and agility. Winter brought skiing, skating and high ski jumps.

Cosmonaut No. 3 distinguished himself as a skater and even more as a skier. He had learned to ski in the north woods where he worked as a forestry technician.

We also tested our men on the "rocking platform." It looked easy—all a trainee had to do was to mount a round table that could be rocked in all directions and hook himself to a safety belt attached to a rope hung from the ceiling. The operator at the control panel then set the platform "dancing" at all sorts of odd angles. The test did not give our men any serious trouble.

The rotor presented more complicated stresses and strains. This installation rotates in three planes—the cabin rotates on one axis, the frame on which it is fixed on another, and the whole installation on a third. There was every reason to believe that the cosmonaut in flight might find himself on just such a merry-go-round.

The soundproof chambers give the trainee an approximate laboratory acquaintance with the quiet he will be experiencing in cosmic flight.

I remember the first "baptism of fire" in this chamber. There was that pregnant moment of silence when the cosmonauts were asked who wanted to make the first "flight." Finally Valeri said, "I'll try it."

The pressure was changed several times and the routine disturbed by bright shots of light and harsh sounds, but he reacted rationally and in good time to all disturbances. He slept soundly, awoke exactly on schedule, and moved promptly to his assigned tasks. Valeri came through the test with flying colors and returned from his "cosmic" voyage in perfect health and good spirits.

• **Toward collective flights**—"I envy the next cosmonaut, he'll have a more serious job to do," Gherman Titov said after his trip into space. Every new flight is a fresh leap forward. The role of the cosmonaut as pilot has been growing apace. Gherman Titov, as we know, tested the manual controls of his ship. He was able to turn it in any direction at will. Cosmonauts No. 3 and 4 could do more complicated maneuvers.

We are nearing the time of collective flights. Spaceships will then be operated by whole crews, just as airliners are. The men will be pilots, radio operators, navigators, scientists, engineers and doctors, but they will all be cosmonauts.

The command of these ships will go, by right, to such experienced pilots as Yuri Gagarin and Gherman Titov. Their ships will be making interplanetary voyages—the first perhaps to the Moon, the second to Mars or Venus.

(Excerpted from August, 1962, issue of USSR.) ⌘



PHANTOM fighter in vertical climb fires Caleb on July 25.



AFTER IGNITING at 39,819 ft., rocket soars 630 n. mi. up.

An M/R exclusive . . .

Project Hi-Hoe Scores First Success

Navy's aircraft-launched, low-cost system could orbit satellites—may have military uses

by Richard van Osten

CHINA LAKE, CALIF.—An inexpensive system for air-launching high-altitude research probes and small orbital payloads is under test and development at the Naval Ordnance Test Station here.

First successful air launch of a two-stage *Caleb* rocket carrying a scientific payload to an altitude of 630 n. mi. took place July 25 (M/R, Aug. 6, p. 10). *Caleb* was carried aloft by a McDonnell F4H Phantom fighter and launched over the Pacific at 35,841 ft. It sent back more than 1100 sec. of telemetry data to Pacific Missile Range sites before disappearing over the radio horizon.

The program is a joint effort of NOTS personnel at the Ridgecrest station and of the Naval Research Laboratory in Washington. Both organizations are hopeful the shot's success will trigger release of further funds for Project *Hi-Hoe*.

• **Research is goal**—NRL says its portion of Project *Hi-Hoe* is purely research—to measure the amount and distribution of helium, hydrogen and oxygen ions in the ionosphere. Though all other systems worked perfectly July 25, an equipment failure prevented taking these measurements. These gases are ionized by solar radiation.

Heart of the NRL payload is an ion mass spectrometer, which covers all known major ions in the atmosphere in one instrument.

NRL points out that while the air-launch technique has been tried before (two earlier *Caleb* shots were unsuccessful), the July 25 launch establishes the method as a proven art.

Though the Navy insists Project *Hi-Hoe*'s purpose is research, it may have some long-range applications. One could be the development of tactical probes, while another is the potential for the development of a scaled-down *Skybolt*-type missile for specific Navy applications.

Caleb is actually a four-stage vehicle using a NOTS-developed NOTS 500 solid-propellant first stage, an ABL 248 second stage, a Mod 400-TG NOTS spherical motor third stage and a NOTS Mod 300 spherical motor fourth stage. An alternate third-stage unit is the NOTS Mod 100-2J, also a spherical motor.

The third-stage motor is closer to a "pure" stage definition than the fourth. The latter serves as a straight stage, but more often as a "kick-in-the-apogee" unit for payload orbit positioning. Length of the *Caleb* vehicle is 200 in. Diameter is 24 in. Weight is approximately 3000 lbs., depending upon configuration and payload.

For the *Hi-Hoe* shots, only two *Caleb* stages were used. Payload weight was 120 lb., but with accessory equipment, overall final probe weight was about 180 lbs.

• **Launch details**—Preliminary data shows *Caleb* was released from the F4H at 35,841 ft. (MSL) at a velocity of 984 fps. Ignition altitude was 39,819 ft. (MSL) at a velocity of 863 fps.

F4H run-in altitude was 24,000 ft.

Velocity at run-in was 1430 fps. before pull-up. Nominal release attitude for the aircraft is 85 degrees. This value plus the aircraft's angle of attack actually results in a greater-than-vertical launch attitude—a technique akin to over-the-shoulder delivery of nuclear weapons.

Run-in and launch velocities and altitudes were determined through computer studies as an optimum trade-off in velocity and altitude vs. payload and basic F4H performance.

Early data also shows that payload reached an altitude of about 630 n. mi. with a horizontal distance of 730 n. mi.

• **Ignition information**—There is a five-sec. delay before ignition after aircraft launch. The first-stage NOTS motor, loaded with a polyeurethane-type propellant, burns for 55 sec. The motor is ignited from the aft section. Canted fins on the first stage produce a spin rate of about 4-5 revolutions per sec. for stabilization.

Second-stage ignition and separation is positive and simple. At second-stage ignition, small "cowl flaps" in the stage structure skirt are flipped open to allow excess gas to escape. The flaps open automatically at about 2 psi. of exhaust gas pressure. Balance of the exhaust gas pushes the second stage away from the first. Separation is a "hot launch," or a semi-breech separation. Operation is clean and simple."

Caleb structure is only four percent of total vehicle weight, excluding motor case weights which are "paid for" in propulsion. Total weight for the four fins, for example, is only 11 lbs. NOTS has made extensive use of the so-called Spacemetal material developed by North American Aviation.

• **'Spacemetal' used** — The corrugated-core, sandwich material is used for the fins, second-stage structure, an anti-torque structure in the first stage, and other structural pieces. NOTS is very enthusiastic about the material, pointing out that it is easy to form without a need for special machines.

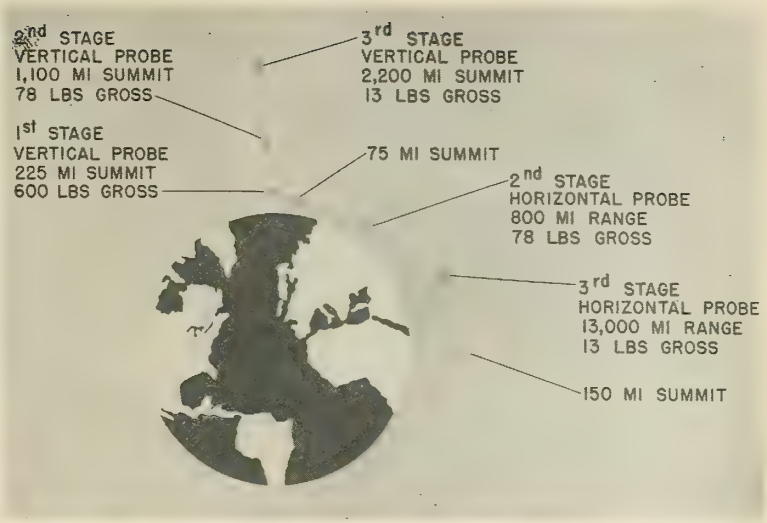


CHART SHOWS scope of possible trajectories of the Caleb rocket.

To meet NRL payload requirements, a yo-yo type of weight and cable device is used in the second stage for de-spinning. Payload spin rate is reduced to less than one revolution per second with this system.

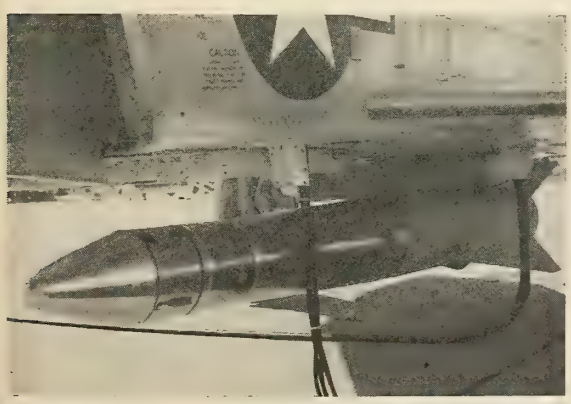
The air-launch concept may be expanded from here. Much depends on final evaluation of the July 25 success as to the merit and costs of *Hi-Hoe*. Minimal costs are cited by NRL personnel as the beauty of the program.—a recoverable first stage (the F4H) and a $60,000-$70,000 rocket vehicle with a one-package payload that can reach deep into space.

A similar (120-lb.) payload launched from the ground requires a much more expensive and sophisticated propulsion system, and would have a top altitude limit of 200 miles, according to NRL.

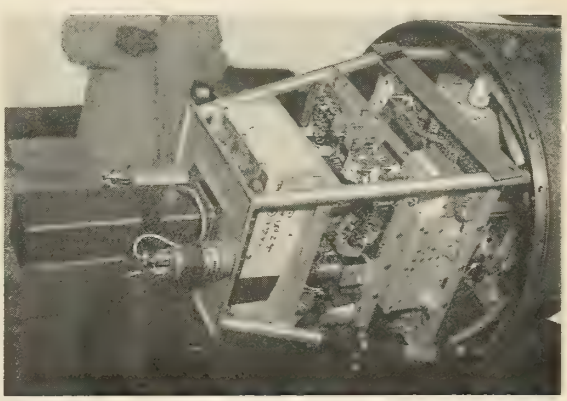
• **Vehicle is versatile** — John D. Nicolaides, director of program review and resources management in NASA's Office of Space Sciences, believes the *Caleb* vehicle could put small satellites (10-50 lbs.) into orbit for a variety of uses. Among these could be a balloon satellite for experimental work and for studying atmospheric drag and the effects on satellites of solar pressure; a rescue satellite that would receive, store and transmit to a central station distress signals from downed aircraft or ships in difficulty; and an ionospheric beacon satellite that would aid in making a time-dependent mapping of the ionosphere.

Nicolaides' views were offered in a paper delivered at the 1961 convention on radio techniques and space research at Oxford University. The author was then technical director for astronautics, Bureau of Naval Weapons.

The first three *Caleb* shots came out of Navy research funds. Though it's too soon to know what direction *Hi-Hoe* may take, both NOTS and NRL hope they can continue the project. NOTS would like to try a more sophisticated system using North American's A3J Vigilante. ⁂



CALEB attached to F4H Phantom prior to July 25 takeoff. Only two of rocket's usual four stages were used for Hi-Hoe.



A LOOK AT payload of July 25 shot. Ion mass spectrometer was to measure ionosphere. Equipment failure prevented this.

Chrysler, Chance Vought win . . .

Missile B Definition Contracts Let

by James Trainor

CHRYSLER CORP. and Chance Vought Div. of Ling-Temco-Vought, Inc., won program definition contracts from the Army last week for the tactical *Missile B* system.

The two companies survived an initial competition with six other aerospace firms.

Total dollar value of the contracts was only $1 million, with each firm receiving $500,000. However, the development and production contract for *Missile B* is expected to be a long-term, multimillion-dollar award.

Announced by Senators McNamara and Hart and Congressman O'Hara of Michigan, the contract calls for a 60-day program definition phase in which the two companies will refine and improve their previously submitted proposals. They are also being asked to develop a weapons system plan showing anticipated scheduling, production and costs.

After evaluation of the two proposals, the announcement said, one of the firms will be chosen to develop the system—provided the program definition phase shows promise.

• **Details scarce**—Both Army and industrial sources refused to give technical details of *Missile B*. However, one company spokesman whose firm did not survive the elimination told M/R that the Army did not prescribe technical characteristics for the system, only performance goals. But it was made clear to contractors that the Army preferred an Autonet guidance package and storable propellants.

Autonet is a simplified guidance technique that uses accelerometers to measure missile drag or displacement. As it senses deviations from the trajectory, it re-ignites the sustainer engine to correct the flight path. This type of system dictates the use of liquid propellants for the sustainer—preferably storable liquids.

Missile B—designed to replace the *Honest John* and *Lacrosse* systems—is to augment conventional artillery fire as a division general support weapon. Reportedly, the system will have a range of from 3-30 miles and carry either a nuclear or conventional warhead.

Although it was initially conceived as a system to launch more than one missile from a single launcher, the Army now says it is probable there will be only one missile per launcher.

Mobility, ruggedness and reliability are prime considerations in the development of the tactical missile system.

Although the Army refuses to verify it, reports say the system can be fielded in 1966 if development is approved.

Col. W. W. Holmes is the *Missile B* project manager at the Army's Huntsville, Ala., Missile Command. ⌗

British Finally Drop Blue Water

by G. V. E. Thompson

LONDON—Cancellation of Britain's *Blue Water* missile has improved chances of the Sperry *Sergeant* in the competition for a NATO surface-to-surface tactical nuclear missile. The British weapon was a contender with the U.S. missile for the short-range NATO role.

The dropping of the British Aircraft Corp. *Blue Water,* which confirms an exclusive MISSILES AND ROCKETS report (M/R, May 14, p. 9), was announced by the British government on Aug. 10.

The announcement said no other tactical weapon will be procured as a replacement for *Blue Water,* which eliminates the British market as a potential for *Sergeant*. The British Army is to rely on the Royal Air Force for its tactical nuclear support.

This means that when the Firestone *Corporal* and Douglas *Honest John* missiles go out of service in 1966 the Royal Artillery will revert to a conventional force. The British Army of the Rhine will have to be reorganized, and the Ministry of Defense has said that *Blue Water's* cancellation will mean that plans for improving the Army's mobility and conventional firepower can now be accelerated.

• **Projects continued**—The Ministry announced that the following projects will continue as planned:

—*T.S.R. 2*. The RAFs' supersonic low-level strike aircraft for both nuclear and conventional roles. This is intended to replace *Blue Water*. A batch of preproduction T.S.R. 2's is being ordered. A. U.S.-developed air-to-surface missile may be produced for this fighter.

—*Blue Steel*. Stand-off bomb, to go into service later this year.

—*Thunderbird II*. Army's antiaircraft missile.

—*Seaslug II*. Navy's antiaircraft missile.

• **New projects** — In the apparent effort to make the *Blue Water* cancellation more palatable, several new military orders and projects were announced. These included:

—*Bloodhound II*. Further work is to be carried out to help the eventual development of a third-generation, large, surface-to-air guided weapon which might be required by all three Services.

—*Swingfire*. Development by English Electric of this new wire-guided antitank missile has been approved.

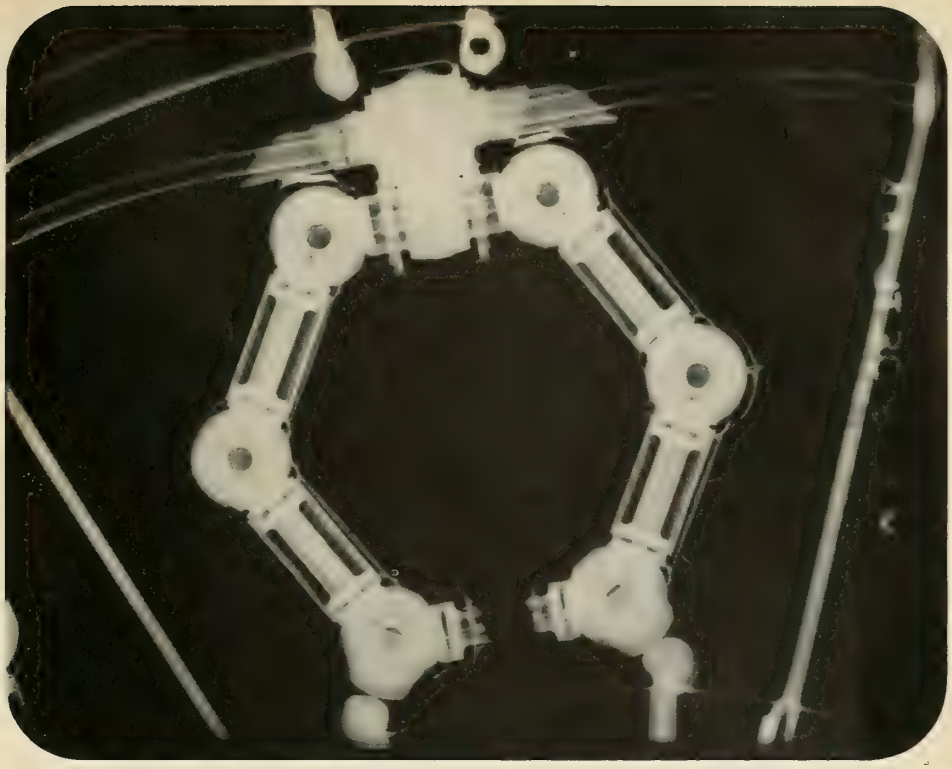
—*C.F. 299*. A new surface-to-air guided weapon, the first medium-range weapon capable of being fitted into small ships, is planned. To be developed by the Hawker Siddeley Group, it would come into service toward the end of this decade.

• **Blue Water explanation** — This reason was given by the Ministry of Defense for the *Blue Water* cancellation:

"In view of the increasing numbers and yield of tactical nuclear weapons which are and will in due course be available to NATO, the Government does not consider it justifiable to continue the development of *Blue Water,* a tactical nuclear weapon for support of troops in the field, which is not planned for use in other theaters. Moreover, hopes that this weapon would be adopted and purchased by other NATO countries have not been realized."

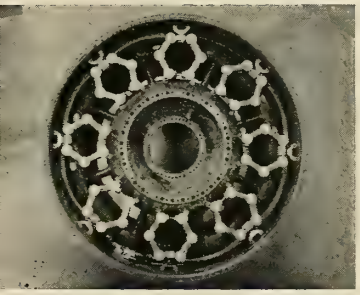
It was also stated that the financial saving was not the primary reason for the cancellation. This is regarded here as an attempt to save face, much like a man saying he bought a Ford rather than a Rolls-Royce because of the radiator shape. ⌗

Radiograph of nozzle cluster which shows welded areas sound and fuel flow unobstructed.



Jet nozzles get their "physicals"

Regularly, American Airlines goes over its Astrojets with a "fine-tooth comb." More than 250 areas are radiographed to scrutinize internal parts—including these jet nozzles.



Jet engine fuel injection nozzle assembly

In its Astrojet aircraft maintenance routine, American Airlines uses radiography to examine more than 250 areas. For example, these jet nozzles are x-rayed for soundness of welds as well as for the presence of any metal chips which might restrict the flow of fuel.

Radiography holds particular advantages for such inspection. It can show the internal soundness of the part. It can probe assemblies which might otherwise require hours to disassemble and, most important, it provides a record of its findings for later reference or study.

Radiography can work for every welder and maker of castings. It helps build business by making sure only high-quality work is delivered. To find out how it can work for you, talk to an x-ray dealer or write us to have a Kodak X-ray Technical Sales Representative call.

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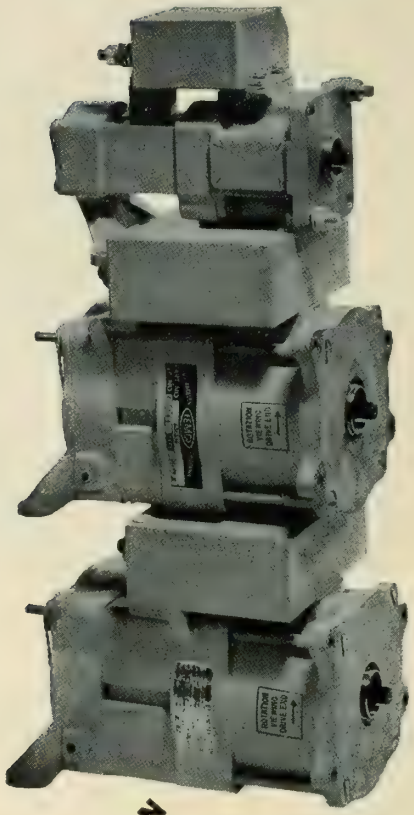
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2 circuit radio noise filters for ungrounded return; Explosion-proof; Fluid resistant (MIL-H-5606 fluid); Air Ambient +32°F. to 325°F.; Sustained Acceleration: 25 g. perpendicular to mtg. flange; Shock: 100 g.; Temperature sensing element imbedded in stator windings; General environmental conditions per MIL-M-8609A, class B; Resistance to ground: 10 meg-ohms min.

Vibration—Sinusoidal and Gaussian random as follows:

5 to 50 cps	6 g's RMS
50 to 2,000 cps	12 g's RMS
5 to 25 cps	0.1 g^2/cps
25 to 50 cps	0.3 g^2/cps
50 to 1,000 cps	0.6 g^2/cps
1,000 to 2,000 cps	rolled off at 12db/octave from 1,000 cps value

SPECIFIC REQUIREMENTS:

D-1356 (First Stage)
Maximum Duty: 5.2 H.P., 12,500 RPM, 24 Volts, 208 Amps, 78% Efficiency.
5 Min. Duty: 3.6 H.P., 16,100 RPM, 28 Volts, 122 Amps, 78% Efficiency, Altitude—0 to 100,000 feet, Life: 100 cycles of 5 min. duty, Weight: 10.8 lbs., incl. filter.

D-1298 (Second Stage)
Maximum Duty: 4.37 H.P., 12,700 RPM, 24 Volts, 188 Amps, 76% Efficiency.
5 Min. Duty: 3.12 H.P., 16,900 RPM, 28 Volts, 113 Amps, 74% Efficiency, Altitude—0 to 300,000 feet, Life: 100 cycles of 5 min. duty, Weight: 9.1 lbs.

D-1302 (Third Stage)
Maximum Duty: 1.35 H.P., 14,500 RPM, 24 Volts, 63 Amps, 66% Efficiency.
5 Min. Duty: 1.13 H.P., 19,100 RPM, 28 Volts, 44 Amps, 68% Efficiency, Altitude—0 to 300,000 feet, Life: 100 cycles of 5 min. duty, Weight 4.1 lbs.

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Technical Countdown

ELECTRONICS

Laser/Microwave Signal Demodulated

The first successful transmission of microwave signals using a light wave as the carrier has been achieved by Stanford University's Electronic Laboratories. The event is considered a major step toward utilizing the enormous wideband potentialities of laser-produced coherent light for communications. Prof. Anthony E. Siegman revealed successful tests of two devices to directly demodulate such transmissions. One, a traveling-wave tube with a photo-emissive cathode, uses light from a mercury vapor lamp rather than a laser. The other device is a fast semiconductor photodiode. Although simpler, more compact and in some respects more efficient than the phototube, it requires an amplifier. A third device enabling demodulation—an FM discriminator microwave phototube—is nearing completion at Stanford Labs.

SNAP 10-A Monitor Being Developed

A prototype system designed to monitor space nuclear-reactor powerplants is being readied by General Electric's Atomic Power Equipment Dept. for evaluation by Atomics International Division of North American Aviation. The GE system includes neutron and gamma detectors of special design to give radiation readings on the reactor. Signals from these detectors will be conditioned by solid-state modules and fed into the telemetry equipment for transmittal to the ground. The detectors are designed to operate at temperatures up to 1000°F.

What's Best Gyro for Tac Missiles?

The debate continues as to what is the best approach to gyros for short-range missiles and probes. Most articulate group at the moment are producers of spring-wound gyros who point out that their types can be checked and re-checked for operational reliability as many as 20 times with no performance degradation—"all we need is a key to wind the spring," they claim.

SS-FM Telemetry Developed

First equipment for single-sideband FM telemetry for use in advanced space systems such as the *Saturn-Apollo* configuration is being built for NASA by Ortronix, Inc. The compact flight instrumentation reportedly is capable of processing simultaneously up to 16 channels of wide-band vibration data. Developers claim it also permits transmission of more wideband data channels on single link than is feasible through use of more conventional telemetering modes.

PROPULSION

Japan Studies 100-Ton Solid Rocket

Tokyo University's Institute of Industrial Science is studying plans for developing a 100-ton solid fuel rocket—the *LD-3*. It would be a three- or four-stage type with the *Kappa, Lamba* or *Mu* rocket in the intermediate stage. Initial thrust of the *LD-3* first stage would be about 920,000 lbs. and, in combination with upper stages, could put satellites in orbit or send instrumented payloads to the Moon. Total cost of developing the booster, related equipment and intermediate stages is estimated at up to $55 million. A tentative target date of 1968 has been set. Technical assistance would be sought from the U.S. on guidance, tracking equipment and launch pads.

Freon Injection for Polaris A-3

Secondary fluid injection for thrust vector control was first proven with the flights of two *Polaris* test vehicles last fall. The Lockheed system, presumably part of the 2500-mile *A-3* missile, uses DuPont's freon as the injectant with a nitrogen pressurizing system. Toroidal aluminum tanks hold the freon while the nitrogen is contained in toroidal pressure vessels. The vector-control system permits the use of higher-energy fuels, something impossible with jetevators because of the erosion problem.

MHD Temperature Reduction Means Proposed

At least four measures can be taken to reduce the operating temperatures of MHD generators, says Dr. Stewart Way of Westinghouse Research Labs, without interfering with efficiency or size. Way proposes using a cheap ore of cesium, reheating the hot gases between several generator stages, lowering the pressure with an exhaust fan and employing superconducting magnets. The lab contained MHD plasma for a record 93 hours in a recent experiment.

Technique Aids Fuel Blending Control

Aerojet-General reports improved control in blending mixed storable fuels used for the *Titan II* has been achieved through use of gas-chromatography instrument techniques. Engineers said use of the method for the first time permits direct measurement of the various liquid components involved in fuel blending. Major fuel constituents for *Titan* are now being measured to within 1% of the full amount present, with minor constituent traces measured to within 15% of the amount present. The vapor fractometers, built by Perkin-Elmer, are capable of detecting substances as small as 10^{-12} gram in a 10^{-9} gram sample.

ADVANCED MATERIALS

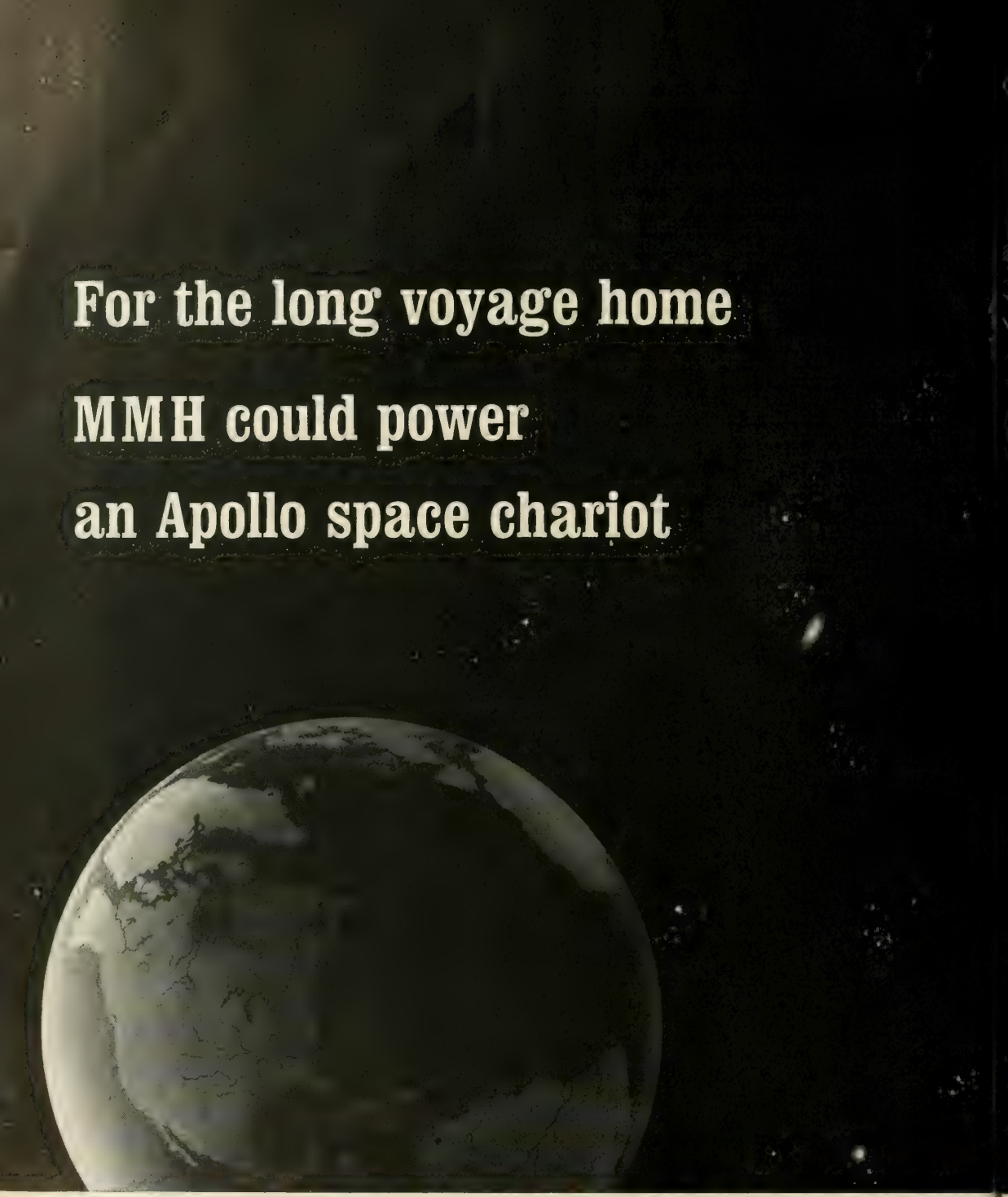
New Coatings Researched at Pfaudler

Practical techniques for applying oxidation-resistant coatings to columbium will be investigated by Pfaudler Permutit under an Air Force contract. The first phase will involve the study of several coating processes emphasizing simplicity, scale-up, and localized repair. The second phase covers an intensive study of the promising systems evolving from Phase I. The firm will examine fluidized bed, slurry and salt-bath deposition techniques. Pfaudler has been working in this area for some time and has patented a fluidized-bed method of coating process.

Printed Circuits Dry-Bonded

New England Laminated Co. of Stamford, Conn., developers of a new chemically dry bonding scheme for packaging multi-layer high-density printed circuits, reports the technique is now being used on a pre-production basis by five major aerospace firms. Company officials claim significant improvements in reliability and circuit performance over so-called "wet lay-up" systems. In the *NELCO* Dri-Pli process, fully-cured, ultra-thin, copper-clad epoxy resin-impregnated woven fiberglass cloth is inserted between circuit layers. The package is unitized by hydraulically applied pressure and heat from a standard press. At present, from three to eight circuits can be produced with the system.

For the long voyage home MMH could power an Apollo space chariot



Monomethyl hydrazine's specific impulse value is second only to anhydrous hydrazine within the storable liquid propellant family. This one-component fuel is completely miscible in all proportions with anhydrous hydrazine to blend a fuel of high performance or density.

MMH has many reliability characteristics worth your investigation. For one thing, it has a much lower freezing point (−62.3°F.) than either pure anhydrous hydrazine or 50/50 mixtures of anhydrous hydrazine and UDMH. In addition, monomethyl hydrazine can be stored safely and without decomposition over a wide temperature range for long periods. And MMH has outstanding



ignition and throttling capabilities.

Monomethyl hydrazine is suitable for all propulsion phases of a space mission. This liquid fuel can be used in the launch vehicle, the upper stage, the retro-rocket and in the various guidance systems.

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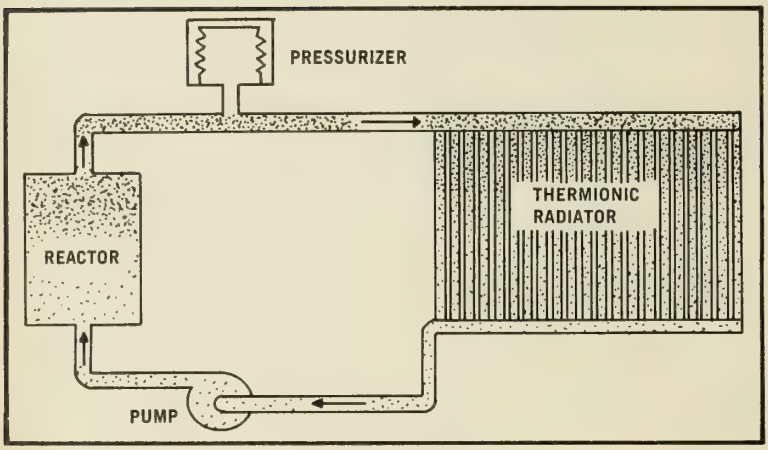
CHEMICALS DIVISION Olin

Circle No. 6 on Subscriber Service Card

Thermionic System for Power in '70's

An M/R exclusive Aerojet-General Nucleonics shows how its conversion method involving one thermionic module could exploit heat from reactor radiators

by William Beller



LIQUID LITHIUM is cycled through thermionic-conversion loop.

A NOVEL THERMIONIC conversion system has shown a new way to achieve highly reliable nuclear-space-power systems in the 300-kw to 1-mw range.

This amount of power will be needed in the early 1970's for sophisticated satellite systems and unmanned interplanetary probes, and probably for extended programs in manned lunar exploration.

Major government projects are now in progress to develop technology and components for such high-power nuclear systems—the Air Force's *SPUR* effort and the Atomic Energy Commission's parallel *SNAP-50* program (M/R, July 23, p. 12). Each is designed to change heat into electricity by means of rotating equipment—possibly the weakest link for long-lived space powerplants.

In a unique thermionic-conversion approach—essentially a static energy-conversion method—conceived by Aerojet-General Nucleonics and successfully demonstrated last month, a single thermionic module produced 74 watts of power for the full test period of 20 hours.

The importance of the test, beyond the fact that it involved what is probably the largest thermionic converter ever made, is that the unit operated at 2200°F—several hundred degrees below the usual temperature for thermionic conversion.

This opens up the possibility of using the heat from a reactor's radiator to drive thermionic units—the AGN concept. Unlike placing the units on the higher-temperature reactor fuel elements, the new idea prescribes low-temperature converters that can be designed within the current state-of-the-art with high reliability.

• **How it works**—A thermionic converter consists of an electron emitter or cathode, a space through which the electrons flow, and an electron collector or anode. Electrons within the cathode are heated to an energy level high enough to boil them off.

In effect, the device acts like an electron-tube diode.

The electrons migrate across the interelectrode space and are collected at the anode. The electron stream then completes the cycle by flowing through an external load.

The power of single converters can be multiplied many times merely by connecting them in series.

Objective of the AGN demonstration was to show in a test loop that the system concept is feasible. It also marked the end of the company's first year's development work on the project, sponsored by the Air Force's Aeronautical Systems Division. Funding was modest: $100,000 from the Air Force, $50,000 from AGN.

• **Test results**—The test was run in a chamber evacuated to 10^{-5} torr in order to simulate a vacuum environment. Liquid lithium was circulated through the cathode by a centrifugal pump running at 3000 rpm and taking suction at 1970°F. The radiator module containing the thermionic converter produced full design power from the heat supplied by the circulating lithium. The liquid metal was cycled at temperatures ranging from 2150°F to 2270°F.

The test proved several things:

—Thermionic converters can put out power at the relatively low temperature of 2200°F instead of the usual ones of above 2500°F.

—A large thermionic converter can operate satisfactorily for an extended period.

—High-temperature lithium can be circulated by a mechanical pump. This technique reportedly had never before been used successfully. One detail: a high-temperature tungsten-carbide bearing on the pump shaft was lubricated by 1000°F lithium.

—The new techniques can be applied directly to large nuclear-space-power systems.

• **Simple and quickly made**—Kenneth T. Johnson, manager of AGN's spacepower department, estimated it would take three to four years to get a prototype of a 300-kw thermionic system if a 2200°F reactor were on hand. Specific weight would be about the same as that of *SPUR* or *SNAP-50*—10 lbs./kw—but "the thermionic system could be developed at less cost simply because you would do your testing on a smaller

scale—on a single module of the radiator," he said.

He added that as you need more power you simply stack radiator modules, whereas when you use turbomachinery converters—the basis of *SPUR* and *SNAP-50*—the systems have to be built full size to test them. "Moreover they are not as flexible as far as power level is concerned," he noted. "But in the thermionic concept within the limits of the reactor you can add the modules you need to get the power you want."

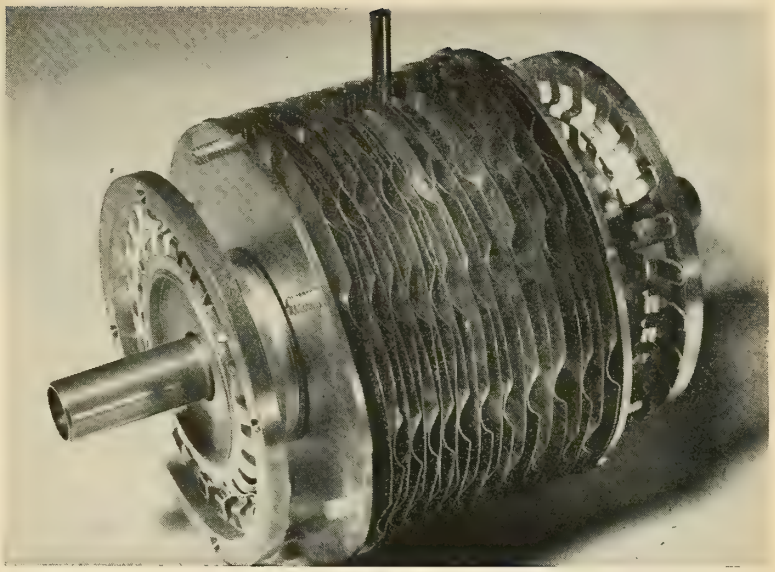
In the radiator module AGN tested, there was one thermionic converter—made by the Electron Tube Div. of the Radio Corp. of America. Its cathode was a 1-in.-dia. tungsten tube about 10 in. long, through which the lithium flowed.

The anode was a molybdenum tube concentric with the anode, the same length and finned. The whole assembly was about 6 in. in diameter and 10 in. long, comprised one radiator module or conversion unit and put out 74 watts.

The converter had a 10-mil interelectrode gap containing cesium gas for space-charge neutralization. The converter's relatively low operating temperature gave a correspondingly low power density of 1 watt/sq. cm., and a conversion efficiency of about 8%.

• **Compared with others**—In *SPUR* and *SNAP-50* as they are now conceived, lithium cools the reactor and then passes through a heat exchanger where a working fluid potassium is boiled; the potassium vapor then expands through a turbine and is re-cycled. This is the bi-metal Rankine cycle.

On the other hand the thermionic system is all-liquid filled. There is no worry about phase separation or whether the liquid vaporizes. Only a pressurizer and a pump are needed: the pressurizer to keep the lithium from boiling in the reactor—at 2200°F operating temperature lithium has an equilibrium pressure about five psia; the pump, to keep the lithium circulating.



MODULE OF thermionic converter. Fins dissipate heat from anode.

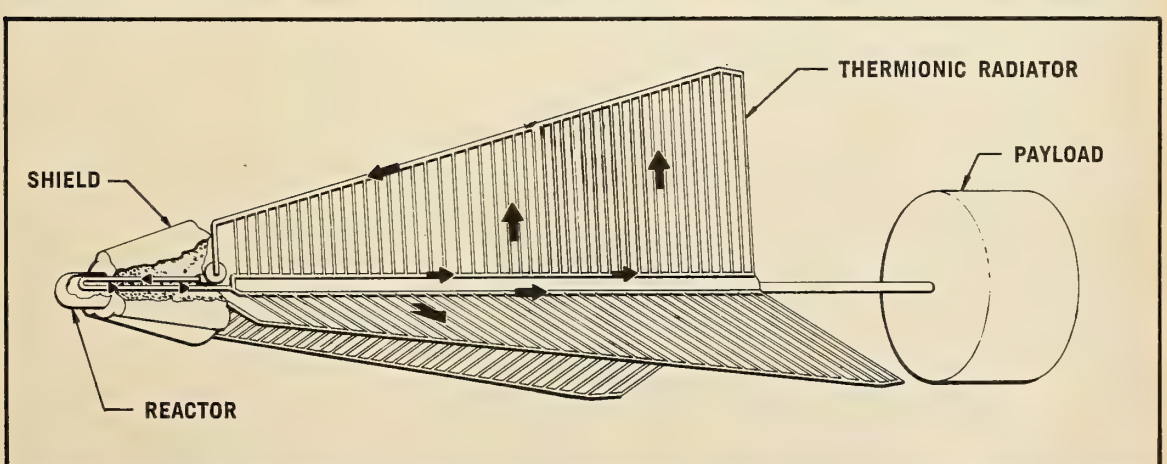
The life of these systems should be fairly long: limiting factor is not the materials used in the electrodes but the metal-to-ceramic seals needed to maintain integrity of the interelectrode gap.

One proposed way to generate nuclear thermionic power is to put the converters on the reactor's fuel elements. To keep the reactor small, the thermionic units would have to operate at power densities possibly as high as 20 watts/sq. cm.; this calls for temperatures of about 3500°F, according to Johnson. "To operate there you would have to drive the fuel elements and their cladding completely out of reason, temperature-wise," he said.

"Using our approach we can put the thermionic converter external to the reactor—in the radiator where power density is not critical," Johnson said. "Then the radiator size can be kept very small and compact, and the weight of shadow shielding correspondingly low. "The entire system is within the present state-of-the-art, unlike the high-temperature thermionic approach."

Another possible advantage of the AGN system is using it to backup a Rankine-cycle system. This advantage, however, may be lost if AEC's present plans to construct a 2000°F reactor are carried into *SNAP-50*: the AGN system needs 2200°F to operate.

AGN has started its Phase II work under Air Force sponsorship and with the same amount of interim funding as Phase I. The work ahead is to build thermionic converters mounted in series, test them for larger power outputs, and go deeper into scientific studies. ⁂



THERMIONIC CONVERTER becomes a "pipe" in the radiator of the reactor.

Surveyor Recorder/Reproducer Tested

CEC system is smaller and lighter than units firm designed for Mercury capsules; new device also has full capability to transmit data back to Earth

by Arthur H. Collins

PASADENA, CALIF.—The engineering prototype of a seven-channel, miniaturized tape recorder/reproducer system for NASA's *Surveyor* lunar-landing spacecraft is now under test at Consolidated Electrodynamics Corp., a subsidiary of Bell and Howell.

Scheduled date for delivery of 14 units of the first production model to Hughes Aircraft Co., prime contractor on *Surveyor,* is Nov. 1.

The instrument represents a significant reduction in both size and weight from the CEC system previously used in the *Mercury* project.

Earlier units weighed 12 lbs. and occupied over 500 cu. in. of payload space. The new system weighs 8 lbs., and requires less than 360 cu. in.

As designed for the *Mercury* capsule, CEC's unit had record-only capabilities. The tapes were recovered with the capsule and played back on ground support equipment. The *Surveyor* storage system is a complete record/reproduce unit with all the necessary electronics to handle inputs from sensors, plus outputs, upon command, to onboard telemetry equipment for transmission to Earth stations.

• **Two-phase operation** — The all-transistorized, reel-to-reel tape system has two separate operational phases in the *Surveyor* mission. Its first use will be to monitor vibrations during boost and landing phases. Once landed on the lunar surface, the recorder will gather geophysical data on "moonquakes," radiation and magnetization from the vehicle's sensing systems.

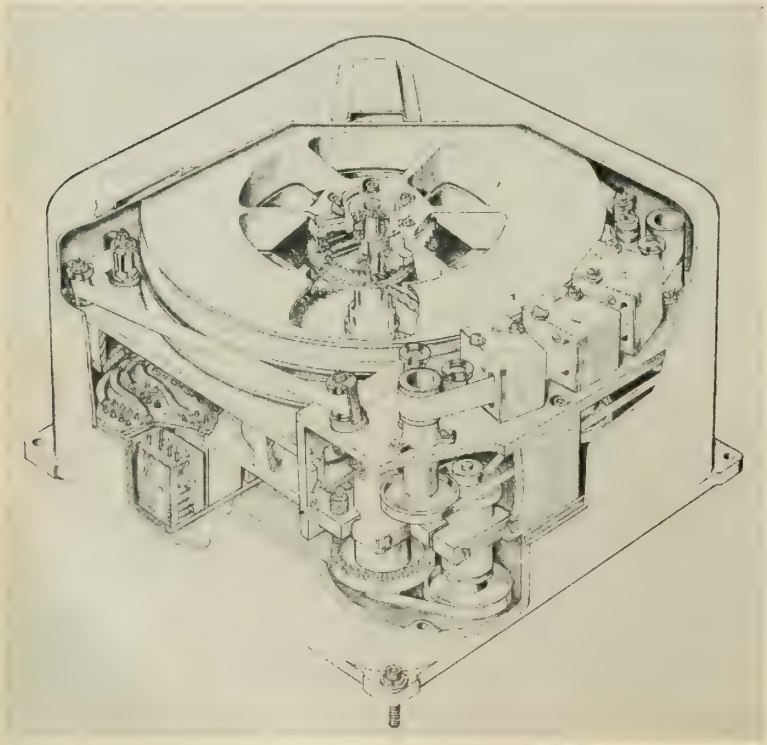
During boost and landing phases, the recorder operates at a speed of 20 in. per second and is capable of handling up to 18 minutes of high-frequency vibration data. Following this period, recording speed is reduced to ⅓ ips for operations on the lunar surface. The slower speed will provide over 18 hours of recording time. Tape playback speed to the telemetry transmitter is a constant 20 ips.

The record/reproduce system uses 2000 ft. of ½-in., 1-mil-thick, Mylar base tape made by Minnesota Mining and Mfg. Co. The 1-mil tape was selected over the ½-mil type used in the *Mercury* recorder because it is easier to handle and more reliable. The tape is a high-quality, thin-oxide, high-temperature specifically designed for applications in a space environment.

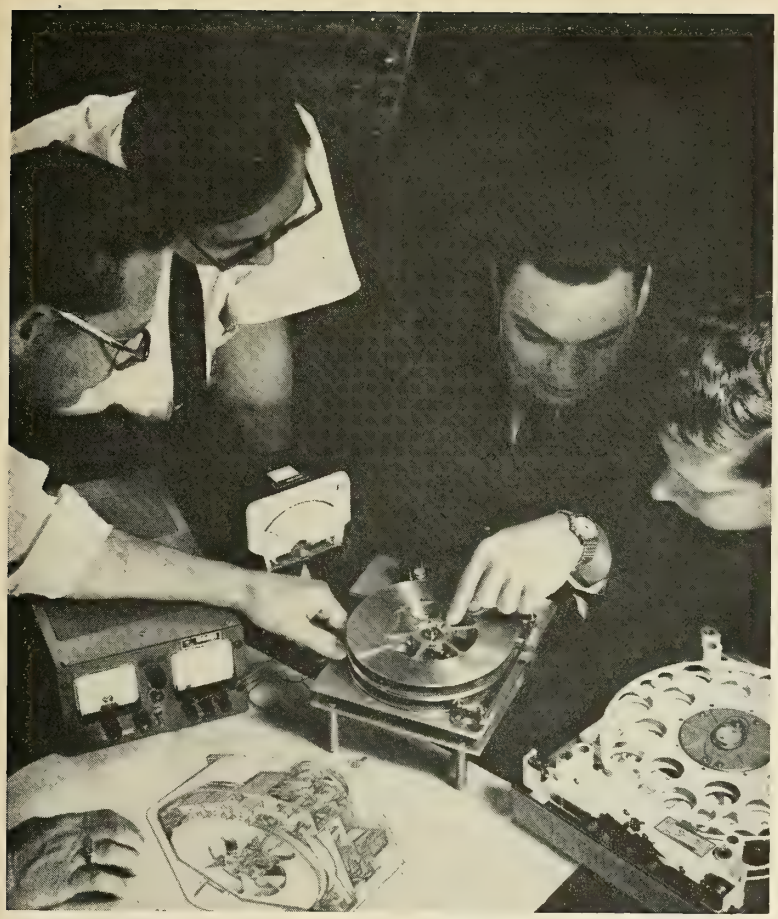
Two rubber-cover capstans drive the tape across the record/reproduce heads for flutter isolation and to minimize variations in tape tension. The capstan transmission uses Mylar drive belts and large-diameter pulleys in critical locations to further minimize flutter.

The tape transport mechanism is designed for low power consumption and low flutter performance with a single, high-efficiency motor which drives the transport forward or reverse, and at high or low speeds. An electric clutch, activated by a signal from an Earth-based control center, changes reel speed and tape direction. A built-in error servo amplifier loop provides drive motor correction signals insuring constant tape speed for both record and reproduce operations.

• **Keeping it tight**—Tape tension is maintained by a "negator" spring mechanism which requires no power yet keeps the tape taut at all times—an important factor for high-quality re-



CUTAWAY DRAWING shows Surveyor recorder-reproducer system in its container.



CEC ENGINEERS discuss the miniature tape recorder designed for Surveyor. Unit operates on 0.65 watts of power, weighs less than 7 lbs., and occupies about 360 cu. in. Recorder can store approximately 25 x 10^7 bits of information. At right is a recorder of the type carried aboard Mercury capsules.

corded data. In a conventional system, "hold-back" devices and "take-up" motors maintain tape tension. But these require a constant expenditure of power in the tape transport system to overcome the tension and operate the tape at the desired speed. About 60 milliwatts of power are required to overcome normal tension conditions of ½-in.-wide tape at 1 ips—tape tension being proportional to tape width.

In CEC's design for the *Surveyor*, the negator springs chop this power requirement by applying a torque between the take-up and supply reels through a differential mechanism. With the capstans providing the only drive force needed, the other types of devices are eliminated.

Bearing friction is minimized by designing all bearing housings with the same thermal expansion characteristics as the bearings. Steel inserts surround the bearings in magnesium members.

Operation of the recorder-reproducer is controlled from an Earth central control which can turn the system on or off, switch back and forth from record to reproduce, or select the desired recording speed. An automatic end-of-tape metal shorting strip is attached to each end of the tape. The metal strip shorts a limit switch to prevent further tape travel—except in the opposite direction.

• **High accuracy** — Sensor input voltages of up to 5v with a minimum input impedance of 100K ohms are accepted by the system. Telemetry output voltage is the conventional 0-5v dc with a 50K ohm load impedance. Analog system linearity is ±1% with gain stability—including a speed stability of ±5%.

Signal-to-noise ratio on the first three channels is 50 db peak-to-peak with a 40 db ratio on the other four channels.

FM recording techniques are used to meet accuracy requirements of the data to be recorded and reproduced. CEC placed special emphasis on design of circuits that could be used during all phases of operation. Both analog and digital input information is accommodated by the same circuits through the use of saturation recording techniques. The FM approach also did away with the cross-talk problems common to direct-record systems.

To eliminate the power requirements of high-frequency erase heads, CEC has designed a special d-c erase head which allows a considerable reduction in power required as well as eliminating some circuitry.

During the boost and landing phase, system frequency response for all seven channels is flat from 5 to 1000 cps ±1% for both record and playback.

• **Response**—For the post-landing, lunar-surface operational phase, response is as follows:

Channels 1, 2 and 3: recording response is flat from 1/60 to 5 cps with less than 1% deviation from 2 to 150 cps. Playback response is flat within 3 db from 1 to 300 cps.

Channel 4: recording response is flat from 1/20 to 20 cps with less than 1% deviation from 3 to 600 cps. Playback response is within 3 db from 3 cps to 1.3 kc.

Channels 5 and 6 record NRZ (non return to zero) digital data at 550 bits per second with a 33,000 bit-per-second playback rate.

Channel 7 handles NRZ digital data recording at a 200 bit-per-second rate with a 12,000 bit-per-second playback rate.

Electronic circuits, including all amplifiers and power supplies, are divided into "cordwood" modules with a typical packing density of 40 components to the cubic inch.

The recorder/reproducer requires 0.65 watts during the recording phase and 1.5 watts for playback. Internal voltage requirements are 17 v, 3 v and −3 v regulated dc. Calculated operating life expectancy of the system is on the order of 1000 hrs.

Temperature tests run from −22°C to 52°C. Vibration testing included exposing the operating system to a 0.6-in. peak-to-peak sine wave at a frequency of 1 to 3 cps, then increasing amplitude to a sine wave having a 3g peak varying in frequency from 3 to 40 cps. This was followed by a 15g rms test at frequencies of 15 to 1500 cps. In shock tests, the system was exposed to 30g for 5 ms for a peak sawtooth exhibited on one axis and a 15g peak sawtooth for 5 ms exhibited on two axes. Other tests will include a 10g acceleration for 4 min., humidity testing at 95% and 72°C and pressure testing at 10^{-4} mm Hg. Test program also involves effects of a magnetic field for 1000 gamma maximum DC and 50 gamma AC. ⁂

Refractories Bow to New Processes

Precise, predictable porosity in refractory metals achieved by Clevite; bonding techniques, and fiber reinforcement plus permeability spells space uses

by John F. Judge

A PROCESS DEVELOPMENT which forms porous bodies of exactly controlled permeability may open new application areas in refractory metals at Clevite Corp.'s Mechanical Research Division.

In one instance Clevite is manufacturing the porous refractory membrane for the Pratt & Whitney fuel cell—a component which might fly aboard the *Apollo*.

"We can control the pore size cross-section accurately within certain limits," says A. D. Schwope, director of MRD, "but our ultimate aim is 1 micron-size pore with 1 micron diameter spacing."

The firm uses powder metallurgy methods, but details of the process were not revealed. Porous bodies in tungsten, nickel, titanium, tantalum, and molybdenum have been made without great difficulty with porosity ranging from a low of 5-10% to 80%.

In addition to this capability in controlled permeability, Clevite experts have succeeded in perfecting solid-state welding techniques permitting the bonding of porous structures to solid materials. The solid metal need not be the same as its porous neighbor.

This total capability leads to any number of missile/space applications. Refractory metals can be used as injectors in liquid thrust-vector-control mechanisms—providing a high temperature-resistant wall that permits a measured liquid flow through it and into the exhaust stream. Porosities can be tailored to the fluid transmission rates required.

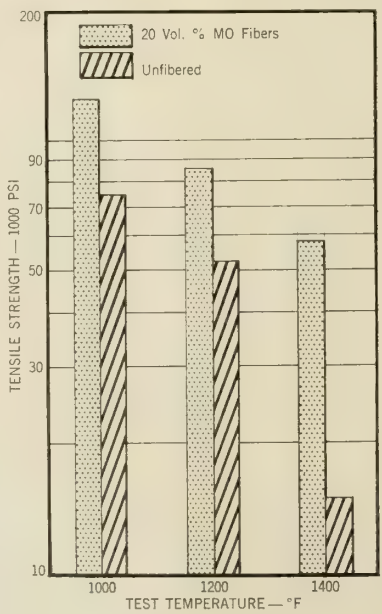
In one instance, MRD has provided a porous-solid part with a flow rate of 50 lbs. per minute through the membrane and a 75 psi drop. Flow factors are functions of the porosity and depth of the membrane and can be calculated through the familiar "pipe" formula.

Many other applications are obvious if the general characteristics of such systems are kept in mind—high-temperature structures coupled to high-temperature permeable sections. Leading edges, nozzle cooling systems, throat inserts and some nuclear uses are under investigation.

• **Ag-infiltration**—Sweat-cooling by infiltrating porous tungsten bodies with silver is another area being actively studied. MRD's high degree of control in porosity means the total theoretical cooling ability of the infiltrant is achieved.

Schwope says even bodies at 95% theoretical density can be infiltrated almost completely. There is no wide range of pore sizes—promoting predictable and uniform infiltrating.

Infiltration brings tungsten out of the brittle category and increases its machinability tremendously. The Clevite process is metallurgical but not really a single-step method. The silver, together with a proprietary wetting agent, is pre-mixed in the tungsten powder and vacuum-infiltrated.



TEMPERATURE effects on tensile strength of fibered and unfibered 90% Ti-6A1-4V.

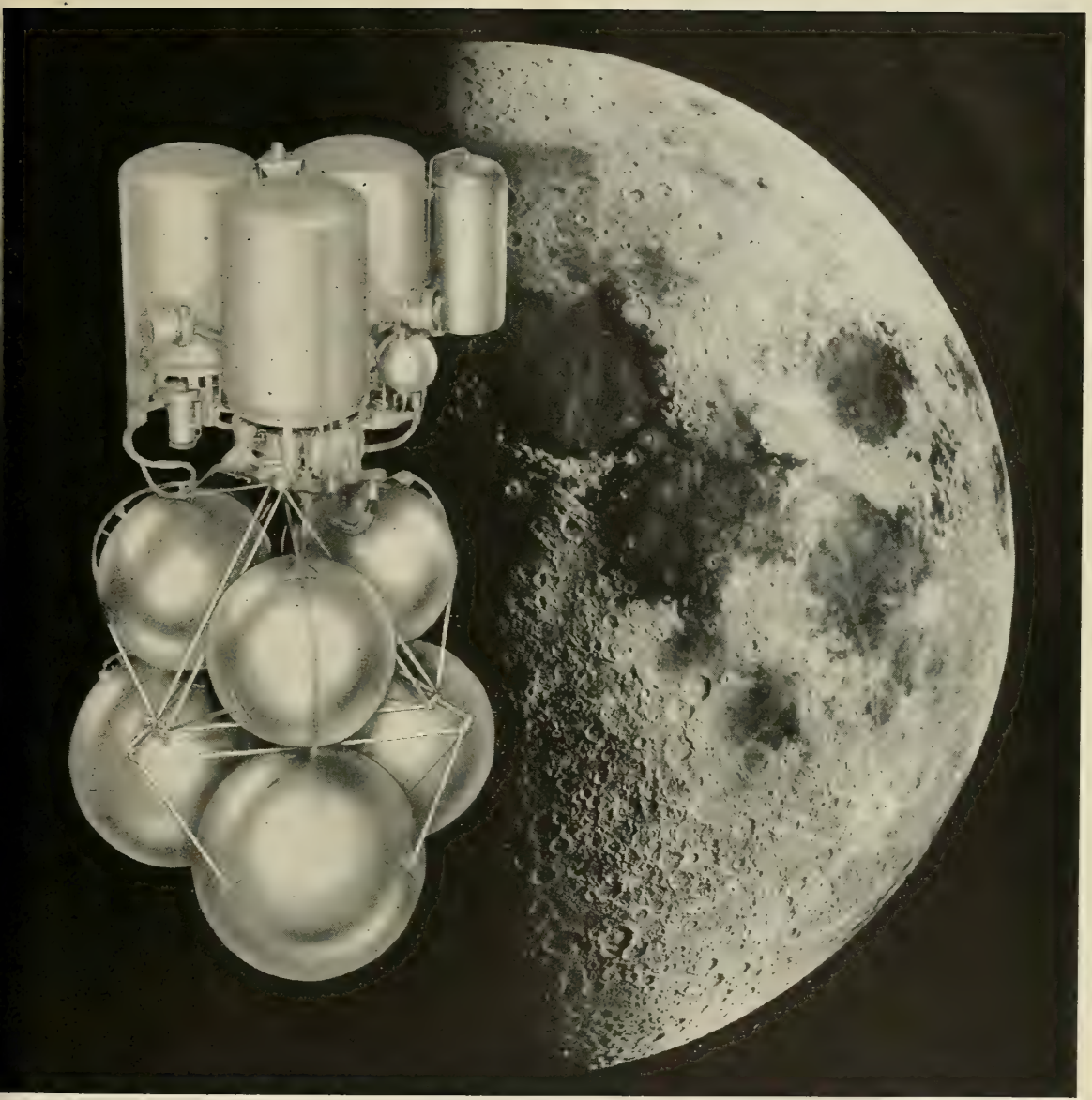
Another major area of research at Clevite—fiber reinforcement—can merge with the porous structure work to produce finished, fiber-reinforced bodies with even higher strengths than currently possible.

Researchers, with some government support, are deep into the basic technology of fiber reinforcement. Shear stresses, fiber lengths, orientation and distance apart in composites, and characteristics of various glass and metal fibers in various matrices are being studied.

Clevite, which did about $91 million worth of business in 1961, has nine operating divisions. Two of these, Cleveland Graphite Bronze and Clevite Transistor, collar the lion's share of the firm's business in automotive bearings and semi-conductors. But there are also Clevite Electronic Components, Clevite Ordnance, Intermetall (Germany), Brush Instruments, Brush Crystal (England), Clevite Harris and Clevite Ltd. (Canada).

Clevite Corp. faced stiffening competition in the mid-1950's, challenging its historic position as the country's leading piezoelectric supplier. A broad and continuing research and development effort yielded new materials and wholly new product lines in this field.

All commercial divisions call on the services of the two central research facilities—Mechanical and Electronic. The Mechanical Research Division concentrates on new materials such as bearing alloys, elastomers, high-temperature metallurgy and fiber reinforcement. The Electronics Research Division covers piezo- and ferroelectricity, semiconductors, ferromagnetism and crystal optics. ⁂



A fuel cell for Apollo

This is a model of a fuel cell designed by Pratt & Whitney Aircraft—the company chosen to develop a fuel cell system for Apollo, America's first manned lunar craft. The Apollo spacecraft will be built for NASA by North American Aviation.

The hydrogen-oxygen cell will supply power for environmental conditioning, communication, instrumentation, and scientific equipment. In addition to generating electricity, the fuel cell will provide water for Apollo's three-man crew.

Pratt & Whitney Aircraft
DIVISION OF UNITED AIRCRAFT CORP
EAST HARTFORD, CONN.

Pratt & Whitney Aircraft's fuel cell is far more efficient than conventional power systems. During tests, cells have demonstrated efficiencies of 70 to 80 per cent.

The fuel cell has a significant role in space. Moreover, it promises to be a significant power source on earth. Pratt & Whitney Aircraft is currently studying fuel cell power systems for such applications as remote-site power, vehicle propulsion, commercial power generation, and other industrial tasks.

From 1200 miles...



to 1500 miles...





to 2500 miles...

in just two years

That's how the Navy-Lockheed team has increased the range of the Polaris missile since it became operational in 1960. And they've done it without increasing the diameter of the missile or its launch tubes. This means that all Polaris submarines are basically capable of carrying all three generations of the missile. Now being flight tested, the A-3 will be operational in 1964. Like its predecessors, it is a year or more ahead of the Navy's original schedule. To meet the demands and deadlines of today's major weapon and space programs, Lockheed Missiles & Space Company has brought together more than 25,000 scientists, engineers and technicians... equipped them with research laboratories, test equipment, and production facilities to handle the most difficult assignments. The constant aim of LMSC management is to coordinate the talents and facilities of industry, the military, and government and academic groups for total development of successful major weapon systems—such as the Polaris missile.

LOCKHEED MISSILES & SPACE COMPANY

Sunnyvale, Calif. • A Group Division of Lockheed Aircraft Corp.



BY AC

AC Spark Plug, The Electronics Division of General Motors, has accepted an exciting new challenge: the development and production of a navigational-guidance system for the first phase in NASA's APOLLO project of manned flight to the moon. This new assignment is another significant step in the progress that is being made at AC . . . progress achieved through the knowledge of AC's highly skilled, highly respected staff of creative engineers.

We suggest that you inquire about the advantages of being associated with our new assignment or other projects now underway at AC. If you have experience in any of the following specialties and have a B.S., M.S., or Ph. D. in Electrical Engineering, Mechanical Engineering, Physics, or Mathematics, send your resumé to G. F. Raasch, Dir. of Scientific and Professional Employment, AC Spark Plug Div., **Dept. 5753H,** Milwaukee 1, Wis.

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The Industry Week

Lockheed Names Apollo Subcontractors

Lockheed Propulsion Co. has named eight subcontractors in its program to build the solid-propellant rocket escape motor for the *Apollo* spacecraft: Exelco Developments, Inc., Silver Creek, N. Y., motor chambers; Airtek Dynamics, Inc., Compton, Calif., after closures; California General, Inc., Chula Vista, Calif., nozzles; Thiokol Chemical Corp., Trenton, N. J., chemicals; Reynolds Metals Co., Louisville, Ky., chemicals; American Potash & Chemical Co., Henderson, Nev., chemicals; NTW Missile Engineering, Inc., Los Angeles, tooling; Arde-Portland, Inc., Paramus, N. J., engineering study program. Lockheed is developing the escape system under a contract with North American Aviation's Space and Information System Div.

New Industry Facilities

Radio Corp. of America has established an applied research laboratory at Princeton, N. J., to perfect techniques for mass-producing superconductive niobium-tin high-field magnets. Rapid and continuous production of niobium-tin is expected initially to benefit nuclear research and the new science of plasma physics. Widespread practical applications will include space communications, relay satellites and frictionless bearings and gyros in missile systems . . . *Fairchild Semiconductor Corp.'s work on the Minuteman guidance computer transistor program is primarily responsible for the firm's decision to build a $2-million administrative/engineering addition to its Mountain View, Calif., plant this fall* . . . Now on stream at Raleigh, N. C., is Corning Glass Works' newly organized Electronics Dept. Among capacitors made there are highly reliable units for the Minuteman and other aerospace vehicles and satellites . . . *Micromatic Hone Corp. is expanding its Santa Ana, Calif., facilities to meet increasing demands of the aerospace industry for lubrication-free bearings, bushings and related specialized products. Two new buildings are scheduled for occupancy by Dec. 1* . . . the Guidance and Control Div. of Litton Industries, Inc., will soon be producing navigation system assemblies in a new Duluth, Minn., plant . . . *Production of atmospheric gases will be more than doubled by expansion of air separation facilities at the Fontana, Calif., plant of Linde Co., division of Union Carbide Corp. The expansion will allow a boost from 430 tons a day to 750 tons of high-purity oxygen to Kaiser Steel's adjacent mill, and is intended primarily for service to the West Coast aerospace industry, Linde's major market.*

New Companies, Affiliations, Mergers

Techniserv Corp. is the name of a new firm headquartered in Los Angeles that was created to meet a demand for professional field maintenance services for manufacturers and users of complex electronic data systems. In addition to the home site, service centers will be located in Washington, D. C., Boston, St. Louis, Denver and Albuquerque, N. M. . . . *An affiliation to provide each with increased facilities and better access to coast missile sites links Radiation, Inc., Melbourne, Fla., and Dynatron Laboratories, Camarillo, Calif. The association gives Radiation a California location and Dynatron an East Coast base. Radiation makes precision electronic systems and Dynatron's line includes radar synchronization systems* . . . Technical Systems, Inc., Los Angeles, has acquired controlling interest in Computer Equipment Corp., West Los Angeles manufacturer of electronic cable and quantizer instruments . . . *Burroughs Corp., Detroit, has acquired Strand Engineering Co., Ann Arbor, Mich. research and engineering company specializing in data display and industrial automation, for an undisclosed sum. Strand was a unit of Datronics Engineers, Inc.*

International News Briefs

The Dai-Nippon Celluloid Co., Osaka, Japan, is seeking a licensing agreement with Aerojet-General Corp. to manufacture solid fuel for missiles. Aerojet-General has offered to sign a technical assistance license agreement in those categories not classified secret . . . *Vascoloy-Ramet Europa N. V. is the name of V-R's new facility in Zwolle, Holland. The plant is now producing cemented carbide tools and blanks, and will help the manufacturer increase its Common Market, Scandinavian and British business* . . . The first Who's Who in the USSR, a 962-page book, contains the biographies of more than 4200 Soviet personalities, including scientists, engineers, military leaders and politicians. Compiled by the Institute for the Study of the USSR in Munich, Germany, it is available in the U. S. from Scarecrow Press, 257 Park Ave., New York 10, N. Y. Price: $21.

Potpourri

A North American Aviation, Inc., geologist and geochemist will teach the first class in lunar geology in an American university beginning next month. Dr. Jack Green will instruct the night graduate course at the University of Southern California. His work at NAA is concerned with how man can use whatever he finds on the Moon for survival . . . *In an Air Force study program, Minneapolis-Honeywell has developed a method called reiterative freezing (freezing a solution several times) that's said to be feasible for extracting drinkable water from urine. It could help solve the problem of supplying water for astronauts on long space flights* . . . Small businesses in the Southeast are learning how to do business under defense contracts at a series of small business education forums sponsored by the Orlando, Fla., division of Martin Co. Atlanta and Savannah were first on the itinerary for a team of Martin procurement and quality control representatives, plus key Small Business Administration and Armed Services Small Business officers. Other Southeastern industrial areas to be covered are Knoxville and Nashville, Tenn.; Mobile and Birmingham, Ala.; Miami and Jacksonville, Fla.; Columbia, S. C.; Charlotte, N. C.; Jackson, Miss., and New Orleans.

contracts and procurements

AWARDS

AIR FORCE

$57,450,000—**Boeing Co.,** Seattle, for *Minuteman* missiles and related equipment (supplemental contract).

$18,600,000—**Boeing Co.,** Seattle, for follow-on research and development for the *Minuteman* missile weapons system (supplemental contract).

$15,690,000—**Boeing Co.,** Seattle, for work on the *X-20 (Dyna-Soar)* program.

$13,000,000—**Boeing Co.,** Seattle, for ground support equipment and hardware for operational wings of the *Minuteman* weapons system.

$12,803,651—**Hercules Powder Co.,** Wilmington, Del., for research and development work on Stage III *Minuteman* motors at Bacchus, Utah (3 supplemental contracts).

$7,200,000—**General Electric Co.,** New York City, for work on space vehicles (supplemental contract). Work to be done at Philadelphia.

$5,144,000—**American Air Filter Co., Inc.,** Rock Island, Ill., for production of environmental control systems for *Minuteman* installations at Ellsworth AFB, Rapid City, S. D. Work to be done at St. Louis.

$3,200,000—**Avco Corp.,** New York City, for work on re-entry vehicles (supplemental contract). Work to be done at Wilmington, Mass.

$2,890,000—**Hughes Aircraft Co.,** Culver City, Calif., for production of *Falcon* missiles and related items (supplemental contract). Work to be done at Tucson, Ariz.

$2,744,000—**Systems Development Corp.,** Santa Monica, Calif., for development and preparation of system training programs.

$2,000,000—**Avco Corp.,** New York City, for work on re-entry vehicles (supplemental contract). Work to be done at Wilmington, Mass.

$2,000,000—**General Dynamics Corp.,** New York City, for installation and checkout of *Atlas* missiles.

$2,000,000—**General Dynamics Corp.,** New York City, for work on *Atlas E* improvement program (supplemental contract). Work to be done at San Diego.

$1,567,037—**Elgin National Watch Co.,** Elgin, Ill., for work on a classified project.

$1,108,000—**General Electric Co.,** New York City, for work on space vehicles (supplemental contract). Work to be done at Philadelphia.

$1,000,000—**Bendix Corp., Systems Div.,** Ann Arbor, Mich., for the field testing of a ballistic missile device developed under an existing contract at White Sands Proving Ground. N. M.

$1,000,000—**General Precision Aerospace,** Little Falls, N. J., for development, fabrication and installation of a celestial-inertial test complex for guidance systems at Holloman AFB, N. M.

$98,992—**Electro-Optical Systems, Inc.,** Pasadena, Calif., for a new spacecraft propulsion concept, a solar hydrogen rocket.

$81,670—**Electro-Optical Systems, Inc.,** Pasadena, Calif., for thermal arc jet research.

Martin Co., Denver, for design, development, fabrication, functionally testing and delivery of a complete solar-illuminated photosynthetic oxygenator (undisclosed amount).

Martin Co., Baltimore, for design and test of an experimental model of an algae-filled device which could produce oxygen to sustain astronauts on prolonged space flights.

ARMY

$480,964—**General Motors Defense Research Laboratories,** Santa Barbara, Calif., for laboratory study of optical and radar characteristics of simulated missiles re-entering the atmosphere.

$150,000—**Midwest Research Institute,** Kansas City, Mo., for development and production of compounds to be used as turbojet and rocket fuels.

Goodyear Aircraft Corp., Akron, Ohio, for study of advanced antenna designs for possible use in future ground-based structures and orbiting satellites.

NAVY

$9,490,000—**General Dynamics Corp.,** Pomona, Calif., for continued production of *Terrier* and *Tartar* missiles.

$4,828,962—**Westinghouse Electric Corp.,** Sunnyvale, Calif., for engineering services on *Polaris* launching systems.

$1,900,000—**Goodyear Aircraft Corp.,** Akron, Ohio, for continuation of research and development of the *Subroc* missiles system.

$1,472,483—**Sperry Gyroscope Co., Marine Div.,** Syosset, N. Y., for design, installation and maintenance of *Polaris* training equipment at the Navy Guided Missile School, Norfolk, Va.

$555,198—**Vitro Laboratories Div. of Vitro Corp. of America,** Silver Spring, Md., for systems engineering services for the *Terrier* and *Tartar* guided missile weapons systems, engineering services on a torpedo director, documentation and training course on *Terrier*.

$450,000—**Fairchild Stratos,** Wyandanch, N. Y., for conversion of an AN/SPQ-2 "Spook 2" radar to an AN/SPQ-6 "Spook 8" radar which will be used for monitoring space missions and missile firings on the Pacific Missile Range.

Space Age Materials Corp., Woodside, N. Y., for a quantity of electronic control devices used in the operation of missiles (undisclosed amount).

NASA

$141,100,000—**Douglas Aircraft Co.,** Santa Monica, Calif., for development and construction of the *S-IVB* upper stage of the *Saturn C-5* booster to be used in *Apollo* manned lunar flights.

$2,000,000—**Collins Radio Co.,** Dallas, for a ground-tracking station in connection with the *Nimbus* weather satellite in Fairbanks, Alaska.

$1,000,000—**Electronic Communications, Inc.,** St. Petersburg, Fla., for communications equipment and services for the *Saturn* program.

$507,100—**Kaminer Construction Co.,** Chamblee, Ga., for procurement, fabrication, installation and checkout of the mechanical and electrical transfer systems on Pad A of Complex 37 at Cape Canaveral.

United Technology Corp., Sunnyvale, Calif., for study of high-performance nozzles for solid-propellant rocket motors, for investigation of fundamental hypergolic ignition phenomena under dynamics flow environments, and for development and testing of an advanced rocket propellant (3 contracts—undisclosed amount).

Rocket Research Corp., Seattle, for development and manufacture of a microthrust balance.

INDUSTRY

$11,700,000—**General Electric Co.'s Large Jet Engine Dept.,** Cincinnati, from **Thiokol Chemical Corp.,** for continued production of first-stage rocket motor cases for the *Minuteman* missile.

REQUESTS FOR BIDS

GENERAL PROCUREMENTS

Hercules Project Office
U. S. Army Missile Command
Redstone Arsenal, Ala.

The Army Missile Command proposes to procure from John Gombos Co., Clifton, N. J., horn waveguides for the *Nike-Hercules* Missile. This synopsis is to publicize possible subcontract opportunities and all inquiries relative to subcontracting must be referred to John Gombos Co., Clifton, N. J.

Supply Department
Puget Sound Naval Shipyard
Bremerton, Wash.

Necessary services and material to provide cap plates, associated parts and hardware for *Tartar* magazine cover in accord with various drawings—20 sets—IFB 251-45-63B—Bid opening 29 Aug. 1962. Bid sets and drawings will be furnished until supply on hand is exhausted.

Warner Robbins Air Material Area
Robbins Air Force Base, Ga.
Attn: Procurement & Production

Parts kit, separator, FSC MSSB 20-895-5815, 362 ea.—kit "D" for modification of missile equipment maintenance sets (MEMS) TM76B spare load panel assembly No. 2, FSC MSSB 4935-K3301532D, 3 ea.—kit "B" for modification of missile equipment maintenance sets (MEMS) TM76B spare control panel assembly, FSC MSSB 4935-K3301532B, 3 ea. parts kit, FSC MSSB 1420-873-7992, 5 ea. kit "C" for modification of missile equipment maintenance sets (MEMS) TM76B spare load panel assembly No. 1, FSC MSSB4935-K3301532C, 2 ea. cover assembly, FSC 49357768799SB, 7 ex. Destinations to be furnished. Complete data not available. Notice is given that specs, plans or drawings relating to the procurement described above are not available and cannot be furnished by the government. Request for proposal has been forwarded to a number of firms including the following: Martin Marietta Corp., Baltimore 3, Md., and Fairchild Stratos Corp., Stratos Div., Manhattan Beach, Calif. It is suggested that small business firms or others interested in subcontracting opportunities make direct contact with the above firms.

Directorate of Procurement
Headquarters, Air Force Flight Test Center
Attn: FTKLC
Edwards Air Force Base, Calif.

Services, Ling Temco Vought Corp., Texas., manned aerospace flight simulator. This synopsis is for subcontracting purposes only. Proposals will not be accepted—RFP FTKL-63-58.

Directorate, Procurement and Production
Middletown Air Material Area
Olmstead Air Force Base, Pa.

Contract technical services for GPA-73 radar and transportable passive satellite communications terminal by 1 tech. rep. for 30 man months. Negotiations will be conducted with General Electric Co., Inc. (D. E. D.) Defense Systems Div., Northern Lights Office Bldg., Syracuse, N. Y. This is a continuation of Contract AF 33(600)-43230. Inquiries must refer to RFP MA-4415-1-PDC. For info only.

HERE IS A PARTIAL LISTING OF CONTENTS

UNITED STATES GOVERNMENT:
Dept. of Defense, Army, Navy, Air Force, NASA, AEC, Small Business Admin., related House, Senate, and joint committees.

INDUSTRIAL SECTION:
Detailed listings of major missile/space manufacturers and leading component manufacturers . . . names, addresses, telephone numbers.

COMPANY REPRESENTATIVES SECTION:
Listing company representatives stationed in Washington and in most strategic missile/space areas.

INTERNATIONAL SECTION:
Covers all countries with missile/space activities, plus all NATO member nations.

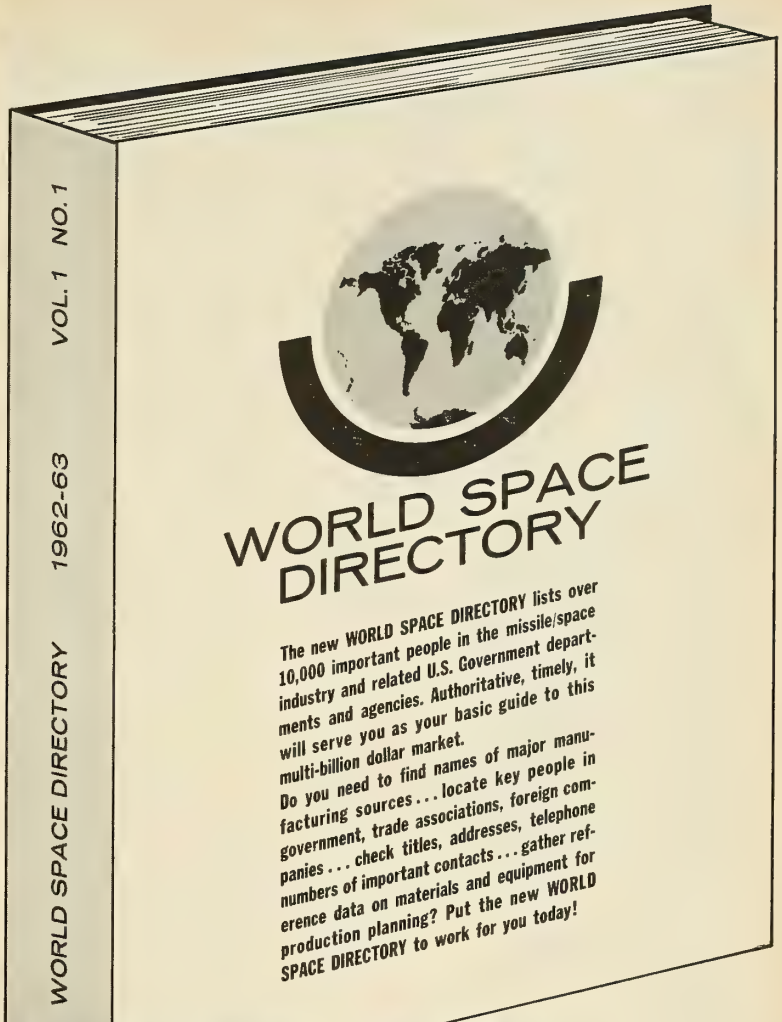
PERSONNEL INDEX:
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soviet affairs

By Dr. Albert Parry

The latest Soviet criticism

of Project *Mercury*, in addition to stressing the Russian spaceships' superiority in rocket thrust and payload, includes the following points: "Reserves of regenerative elements, which absorb water vapors and produce oxygen, also reserves of water and food, also sources of electrical energy on the spaceships of the *Vostok* type—all this will suffice for a space-flight of 10 days and 10 nights. But the corresponding systems of the *Mercury* will supply enough for 28 hours only." Thus writes L. Abramov, a Soviet engineer, in his article "The *Mercury* Lags Far Behind the *Vostok*," printed in the Moscow *Trud* prior to the double launch of *Vostoks III* and *IV*.

Supply of oxygen is much better

organized on the Soviet spaceship than in the American rocket cabin, Abramov continues. "The air-conditioning system on the Soviet ship *Vostok*," he writes, "guarantees a normal concentration of oxygen in the cabin's atmosphere. The regeneration of the air's components is carried out with the aid of highly active chemical compounds. This system not only automatically reacts to a shortage of oxygen, but, when there is an excess of oxygen, the system reduces it. But on the *Mercury* ship, pure oxygen is used in the cabin during space-flight. It is supplied from the cylinders in which it is contained. This is not safe because any collision with small meteorites may cause holes in the cabin's frame, whereupon the heightened volume of oxygen in the cabin may lead to a fire."

The cooling system in the *Vostok* ship

is much more reliable, the Russian writer claims. Gherman Titov was much more comfortable during his 25 hours and 18 minutes in flight than either John H. Glenn or M. Scott Carpenter felt during their flights of less than 5 hours each. Lt. Cmdr. Carpenter's discomfort is particularly stressed by Abramov, who, by the way of comparison, points out that Major Titov "did not close his spacesuit's helmet over his head during the entire flight." The Soviet writer notes: "The air temperature, not alone in Titov's spacesuit, but also in his cabin, remained normal. Moreover, the cosmonaut could regulate it in the cabin at will within the range of 10 to 25 degrees Celsius. We may surmise that Carpenter longed for such an opportunity when the *Aurora's* temperature neared 50 degrees Celsius!"

Landing of spaceships is also

more precise and reliable in the Soviet case than in the American, Abramov declares. Gleefully he cites Carpenter's overshoot as he praises the exactitude of Gagarin's and Titov's landings. Abramov writes: "After more than one day and one night in outer space, Gherman Titov tried out the method of landing separately from his ship. He ejected himself in a seat and smoothly descended by parachute. We must note that the *Mercury* spaceships do not have any such alternate system of their astronauts' landing at all."

When will the *Mercury* men

attempt a 24-hour space-flight? Only in 1963, "two years after the spaceflight of Gherman Titov!" Abramov remarks that the Americans plan to increase their oxygen supply for this "only by 50 per cent"—as against the supply they have in a *Mercury* spaceship now. The Soviet writer implies that Americans simply cannot increase such a supply by any higher ratio. For it all comes down to the basic question of rocket thrust and the size of payload: "orbiting of each extra kilogram of weight is an extraordinarily complex problem" for America's rocket effort. So gloats the Russian engineer as he assures the Soviet reader that his socialist country is still in its orbital lead over capitalistic America. (See *"Vostok II's* Re-entry Design—An Educated Speculation" in MISSILES AND ROCKETS for July 9, 1962, p. 18.)

Vostoks III and IV

(Continued from page 13)

Apparently, although no actual space rendezvous was attempted, the cosmonauts were testing techniques which might be used to link spacecraft in orbit. Soviet scientists are reported to favor the Earth-rendezvous method for achieving a manned lunar landing, rather than the lunar-orbit method selected by the U.S.

In fact, Soviet space scientists indicate that the flights of *Vostok III* and *IV* have proved the feasibility of manned orbital space stations from which spaceships can take off for the Moon. Premier Khrushchev in a special message to Popovich hailed the flights as "the first to blaze the trail toward group flights into space."

Soviet scientist Konstantin Palatov, discussing the radio link between the two craft, said that the problem of communications in outer space between spaceships "flying between the planets Mars and Venus may be solved today."

The long duration of the twin space flight did not have any adverse effects on the cosmonauts, Tass said following the flights. This allayed to a degree the fears born of Titov's "seasickness" during his orbital flight.

However, Soviet scientist Vitaly Bronstein warned that even longer space flights would be necessary before space scientists could be certain that long periods of weightlessness would not affect cosmonauts. A round-trip to the Moon, he points out, would take 10 days—therefore "the next space flights will be longer" in order to provide additional data.

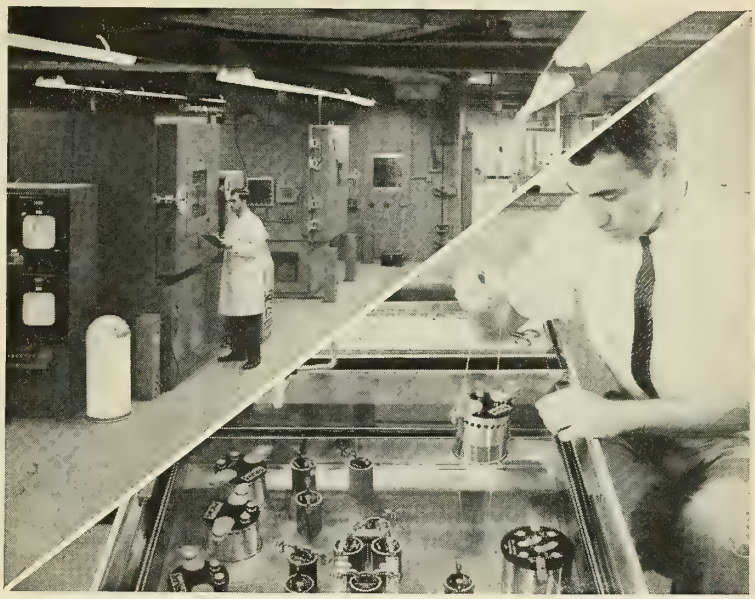
• **Other experiments**—In addition, Tass reported that the two cosmonauts periodically freed themselves from their couches and moved around the space cabin, performing various experiments under weightless conditions.

Dosimeters measured the amount of radiation that each man received as well as that received by various biological test packages. These included fruit flies, chlorella, and the seeds of peas, wheat, pine and beech trees.

While in orbit, the cosmonauts ate conventional food—including meat, fruit, sandwiches and pies—as well as specially prepared food from tubes similar to those used by U.S. astronauts. They were given coffee, water and fruit juices to drink.

All of the experiments seemed to be on a regular schedule, with the cosmonauts controlling the pace and timing of various tasks. Both men, according to Tass, "solved their scientific and technical tasks successfully." ⌗

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ENVIRONMENTAL EVALUATION

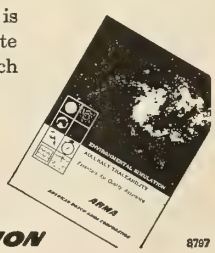
Arma environmental laboratories are among the finest in the nation, originally designed for stringent testing of the all-inertial guidance equipment now in operational service on Air Force ATLAS missiles. These facilities, including the world's most precise large centrifuge test unit, can now provide complete engineering evaluation services for contractors. Outstanding simulation equipment plus a competent staff of experienced engineers is available to help design and develop better, more reliable equipment and components through environmental testing.

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New Products of the Week:

High-Speed Data System

A HIGH-SPEED photographic system of data acquisition is available from Kodak Co. The Kodak Ektaline System cuts delay from hours to minutes in recording and processing test and performance data on everything from rocket engines to a pulse beat.

Components are a series of photosensitive recording papers for data recording oscillographs and computers; special chemical processing; and the new Kodak Ektaline 200 Processor which processes and fully dries a 500-ft. roll of data in less than 3 minutes.

The three types of Kodak Ektaline Paper used in the system are designed to record low, medium and high writing speeds. Features of the paper are wide exposure latitude, resistance to wrinkling, and creasing during processing, absence of cracking and crumbling, high trace quality and density, exceptional dimensional stability and long shelf life.

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Ferrand Optical Co., Inc. has developed a horizontal leveling mirror that can be used with any autocollimating telescope to establish truly vertical sight references directly, simply, and accurately.

The mirror is completely stabilized, air-damped, and suspended in such a way that the surface is always horizontal. The unit is compact and completely self-contained. No outside electric or air connections are necessary.

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Pressure Blanking Valves

A valve for pressure blanking applications has been developed by James, Pond & Clark, Inc. The valve provides completely reliable, foolproof protection for delicate transducers, gauges, telemetering devices, etc.

The 1200 Series valve allows a pressure-sensing device to function during a circuit's low pressure operation while blanking it off at system pressures higher than the sensing device can withstand. It provides instantaneous response to system pressures above the preset point. Closing pressures from 8 to 300 psi. are available.

Circle No. 227 on Subscriber Service Card

Interdigital Microwave

Telonic Engineering Corp is marketing an interdigital microwave filter. Operating on a principle of slow wave structure, the filters employ an assembly of field-coupled, quarter-wave resonators to produce extremely sharp passband characteristics.

The interdigital design inherently provides exceptionally good power-handling characteristics and allows bandwidths to range from 1% to more than one octave. The standard versions will be produced with center frequencies from 500 mc. to 2500 mc. and with bandwidths from 1% to 100%.

Circle No. 228 on Subscriber Service Card

Four-Element Altitude Switch

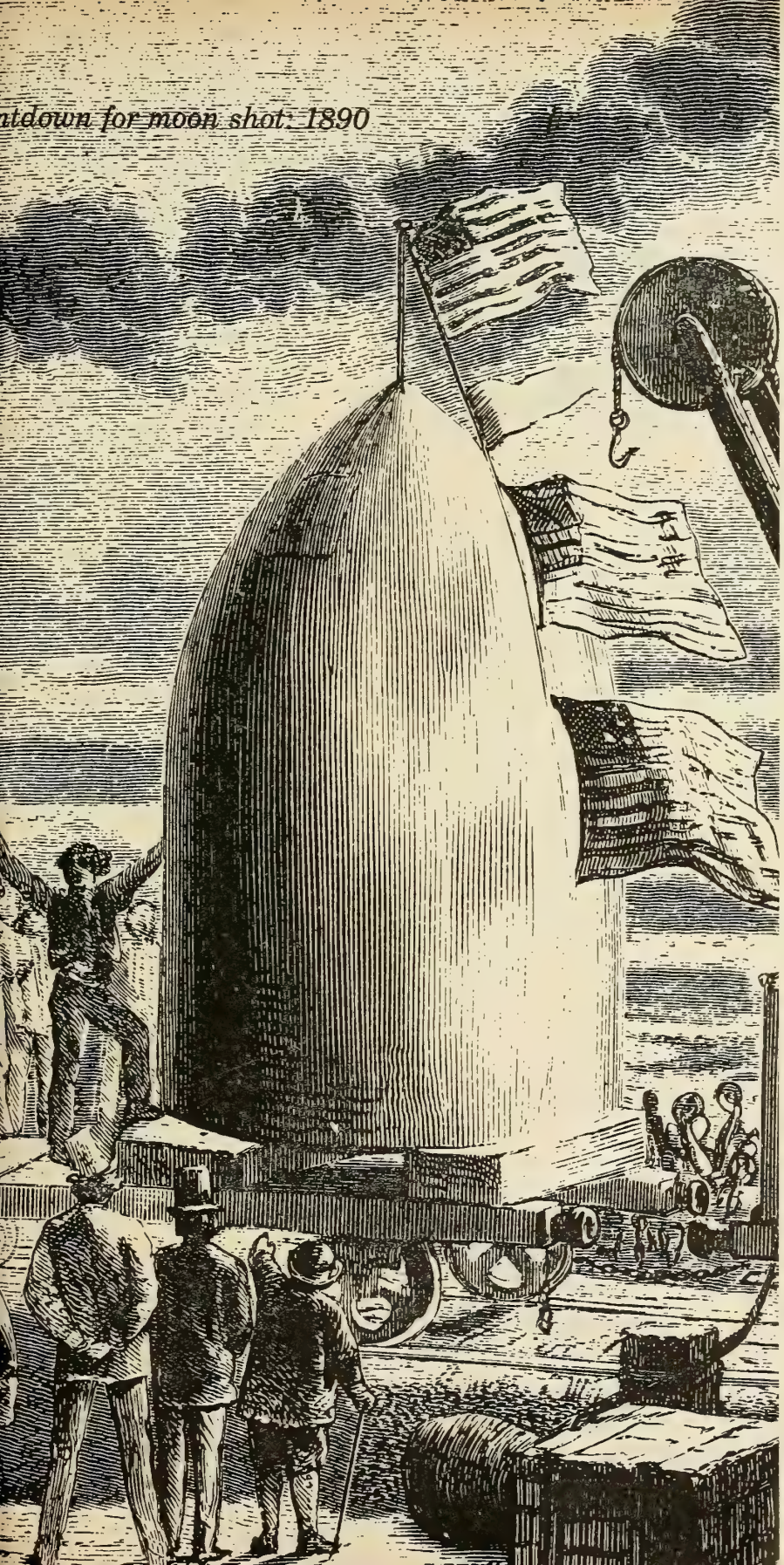
The Pressure Controls Group of Speidel Corp. is marketing a four-element altitude switch, now a standard item designated as Model ARQ-200.

Speidel engineers have developed a unique packaging technique that results



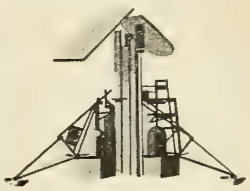
in an extremely compact unit (wt. 24 oz.). This weight- and size-saving technique in no way impairs the reliability of the standard unit. Set range is 1,500/75,000 ft.

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*In Verne's 1890 novel, "From the Earth to the Moon," his spaceship, "Columbiad," was launched from Tampa, Florida—just 120 miles from Cape Canaveral! After missing the moon, the craft returned to earth at 115,200 miles an hour. It plunged into the sea, popped to the surface—and the three men inside were found "playing at dominoes."

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Surge Tester

A Surge Tester for high-speed testing of motors and electrical coils is being marketed by Avtron Manufacturing, Inc. The Model T353 simultaneously tests coils for insulation, wire



damage, incorrect numbers of turns, resistance tolerance, leakage to ground, turn-to-turn insulation, and shorted turns by a one-second application of special "search voltage."

The T353 displays results immediately on a red (no-go) or green (go) light, eliminates oscilloscopes and human error from operator interpretation. The unit may be incorporated into automated assembly lines to minimize handling operations.

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Miniature 10 amp 2 PDT Relay

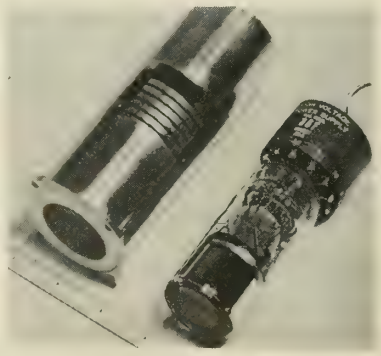
Hurletron Inc. has available a miniature 10 amp, double-pole, double-throw military Relay #9032.

Specifications include minimum current per MIL-R-6106-C Amendment #1, vibration of 20 G's to 2000 CPS and shock of 50 G's 11 ± 1 ms. In addition, this high-speed relay is rated 10 amps with grounded case, and terminal layout is 0.200-in. grid spaced.

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High-Voltage Power supply

A series of miniaturized high-voltage power supplies for photomultiplier tubes, which offer laboratory-level performance in airborne size and weight ranges, is available from Pulse Engineering Inc.



The series 204 consists of four basic elements: a 300 KC oscillator and voltage multiplier chain with a feedback regulator loop which regulates output voltage to ±0.1% of a controlled value; a voltage selector box which controls dynode-stage and overall voltage and assures desired gain; an integral unity gain preamplifier for impedance match; and the final integral assembly of tube-to-power supply, in which the conventional tube base is removed and leads are soldered directly to the power supply. The entire assembly is potted.

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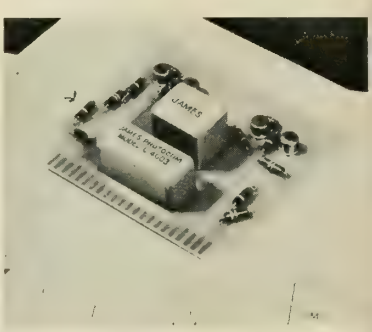
Digital-to-Analog Converter

Navigation Computer Corp. is marketing the Model 541D digital-to-analog converter. The Model 541D provides an analog voltage or current which is precisely proportional to a binary-coded-decimal input. It has an accuracy of ±.0.03 of full scale, and operates at clock rates up to 200KC.

Circle No. 233 on Subscriber Service Card

Photocom Chopper

James Electronics Inc., has developed a printed circuit board mounting photocom chopper. The chopper, known as Package "X," is a solid-state com-



ponent using a photosensitive light-actuated element.

Primary applications for the modulator would be in null-seeking servo systems, low-level d-c amplifiers and other industrial control equipment, as well as military ground support equipment.

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UHF Folded Cylinder

Metcom Inc. is marketing a UHF folded-cylinder TR switch completely mounted for socket-type installation. The MPD-19 is designed for slide installation in WR-2100 waveguide transmission line. It will handle 6 megawatts peak and 12,000 watts average power in the UHF frequency band with extremely long life.

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names in the news

E. Dana Gibson: Appointed assistant to the executive vice president, Thiokol Chemical Corp., Bristol, Pa.

Rodger C. Dishington: Appointed western division manager for Alpha-Molykote Corp., Stamford, Conn.

Raymond A. Rugge: Appointed director of engineering for the Middletown Div. of Aeronca Manufacturing Corp., Middletown, Ohio.

Richard B. Bean: Appointed European area manager for the Product Support Organization of Sylvania Electronic Systems, Paris, France.

John F. Moore: Appointed consulting scientist for Lockheed Electronics Co., Plainfield, N.J.

Benjamin Katz: Appointed director of material, Republic Electronics, Huntington, L.I., N.Y.

Dr. E. C. Galloway: Appointed director of research for the plastics division of Nopco Chemical Co., Newark, N.J.

David Reid, Jr.: Appointed manager of manufacturing, Abrasive Div. of Norton Co., Worcester, Mass.

Robert M. Donovan: Appointed manager of operations of Baldwin-Lima-Hamilton Industrial Equipment Div., Eddystone, Pa. **S. A. Handyside** named manager of finance and controller.

Edward J. Cousin: Appointed director of customer relations of Fairchild Stratos' Electronic Systems Div., Wyandanch, N.Y.

G. Howard Teeter: Joined Hoffman Electronics Corp., Los Angeles, as group vice president.

John A. Dundas: Appointed a vice president of General Dynamics Corp.

Douglas Whipple: Appointed vice president-administration, Fabron Co., Redwood City, Calif.

Jackson W. Granholm: Elected president of Mellonics A-V, Inc., Tucson, Ariz.

Frank W. LaHaye: Elected president of McCormick Selph Associates, Hollister, Calif.

Robert E. McEwen: Named president of FMC S.A., Geneva, Switzerland.

Dr. Gilbert W. King: IBM director of research, named a member of the U.S. Air Force Scientific Advisory Board.

S. Vaughan Andrews: Appointed assistant vice president, administration, of Aerospace Corp.'s San Bernardino, Calif., operations.

Neil L. Brown: Appointed manager of research of Hytech Div. of the Bissett-Berman Corp., Santa Monica, Calif.

George W. Spencer: Appointed manager of the military data systems department of Control Data Corp., Minneapolis.

Arthur F. Dickerson: Named manager of advanced engineering for the Advanced Product Planning Operation (APPO) of General Electric's Electronic Components Div., Schenectady, N.Y.

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The Big Knife

THE U.S. IS FIVE YEARS behind the Soviet Union in space technology. But the real question is not how far behind we are but what we are going to do about it.

A front-page story in the *New York Times* of August 14 reports:

"Leaders of this country's space program are still optimistic about chances of being the first to land astronauts on the Moon. The Soviet Union's success in putting two manned spacecraft into orbit close together has neither surprised them nor caused great concern."

We don't mind telling you we are considerably less optimistic and a great deal more concerned.

The Russian accomplishment has demonstrated in the most vivid manner that the United States, rather than closing the gap, is falling further behind in the advanced technology of space. This nation's prestige and security both are threatened.

Krafft Ehricke, director of advanced studies at General Dynamics/Astronautics, always has been one of the industry's most outspoken and far-sighted scientists. His comment when asked about possible military application of the Soviet flights was right to the point:

"If you have a big knife, you can use it to carve a steak or you can plunge it into your neighbor's back."

Most comment on the new Russian achievement has centered on the accomplishment, or near accomplishment, of what is planned more than two years from now in the U.S. *Gemini* program. This overlooks a number of significant points, particularly in potential military applications:

- We have a highly classified U.S. military program, officially labeled *621A* and more informally known as *Saint I*. This is *Satellite Inspector*, designed for unmanned rendezvous and inspection of unidentified satellites. It is behind schedule and has not yet gotten off the launch pad in an initial feasibility demonstration. The twin Soviet capsules, orbiting within sight of one another, already have accomplished more than Program *621A* will prove. Space-to-Earth television, one of the requirements of *621A*, has been demonstrated by the Soviets.
- The follow-on program, *Saint II* or *621B*, calls for a manned *Satellite Interceptor* with the capability of destroying or neutralizing hostile satellites. This one is not even off the drawing boards. Three-month study contracts for *Saint II* were abruptly cancelled in June, although industry is continuing its work in this area. The Soviet flights have fully demonstrated the feasibility of such intercept and destruction.
- The demonstrated Soviet capability of orbiting two or more manned capsules for long periods of time provides the Russians with a reconnaissance potential which puts the complex and expensive U.S. *SAMOS* and *MIDAS* programs in a shadow. *MIDAS*, indeed, is known to be in serious development trouble due to inability of its sensors to discriminate. Manned reconnaissance is far more effective than spy satellites which depend on cameras or sensors. One of the two Soviet astronauts described, in fact, the major road system he could see in Latin America.
- The U.S. Air Force is carrying out a determined study effort on orbital weapons systems. The Soviets now have demonstrated this capability. A high Department of Defense official told us orbital weapons are impractical because, traveling on predictable paths, they are too easy to knock down. May we ask: With WHAT?

The Russians have demonstrated operational launch and tracking capabilities beyond those of the U.S. They have made *Gemini* obsolescent and are well along the *Apollo* curve.

We're tired of hearing from addle-pated scientists and politicians who insist that the Russians are ahead of the U.S. only in booster performance. This is flatulent balderdash. So is the prophecy that we will pass the Russians in this field as soon as *Saturn* becomes operational. Are we naive enough to believe that the Soviets are standing docile in booster technology while we overtake them enroute to the Moon?

NOW IS THE TIME for the Administration to act and with vigor. The argument that money won't buy time is patently false. It will, up to a point, and we are far from that point. Starting with a decision to take the wraps off the U.S. Air Force and an all-out manned military space effort, there are many things which can be done immediately:

1. Put more money into the *X-20 (Dyna-Soar)* program.
2. Step up financing of *Aerospace Plane*.
3. Fund *Saint II* development, drawing on *Gemini* technology where available and required but going as far beyond it as necessary and as rapidly as possible.
4. Fund development of the manned military space station.
5. Fund an extensive big solid booster program.
6. Forget vague pre-development definition studies intended to conclusively prove before something is built that it will work: If a feasibility study proves feasibility, get on with the job and build it. Be prepared to accept occasional failures.
7. Tear down the vast consulting and in-house empires for research and development and systems engineering. The military services should have sufficient technical capability, either in-house or from non-profit organizations, to competently evaluate proposals and bids and to provide technical surveillance of funded programs. The actual work, including systems engineering, should be left to private industry—which will do a far better job.

Only in this manner can we be assured that the big knife will cut into steak—and not into our back.

William J. Coughlin

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plasma pinch engine — Only One of the Critical Aerospace Areas for which REPUBLIC'S PAUL MOORE RESEARCH CENTER has R & D Contracts

Republic scientists unveiled the world's first light-weight, battery-operated plasma pinch engine last fall. Today they are pushing ahead on a new USAF contract to build a practical working engine to meet exacting space ship requirements for dependable electrical engine propulsion for space missions. A new advanced PLASMA PHYSICS LABORATORY is being built at Republic's PAUL MOORE CENTER, more than doubling the company's facilities for research in magnetohydrodynamics and thermionics. An accompanying 50% increase in the professional staff in this field is scheduled. Other R & D groups at the Center are engaged in a diversity of investigations across the spectrum of aerospace science and engineering.

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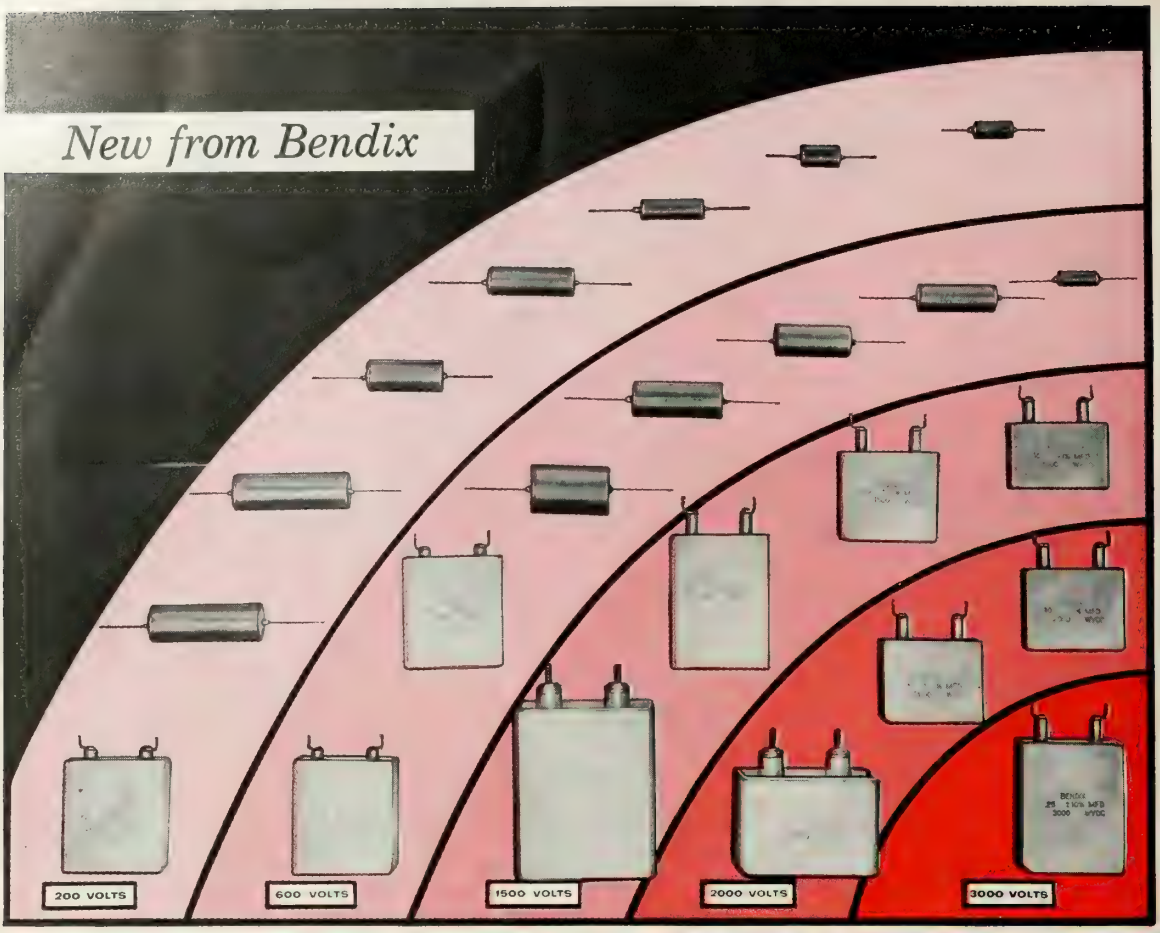
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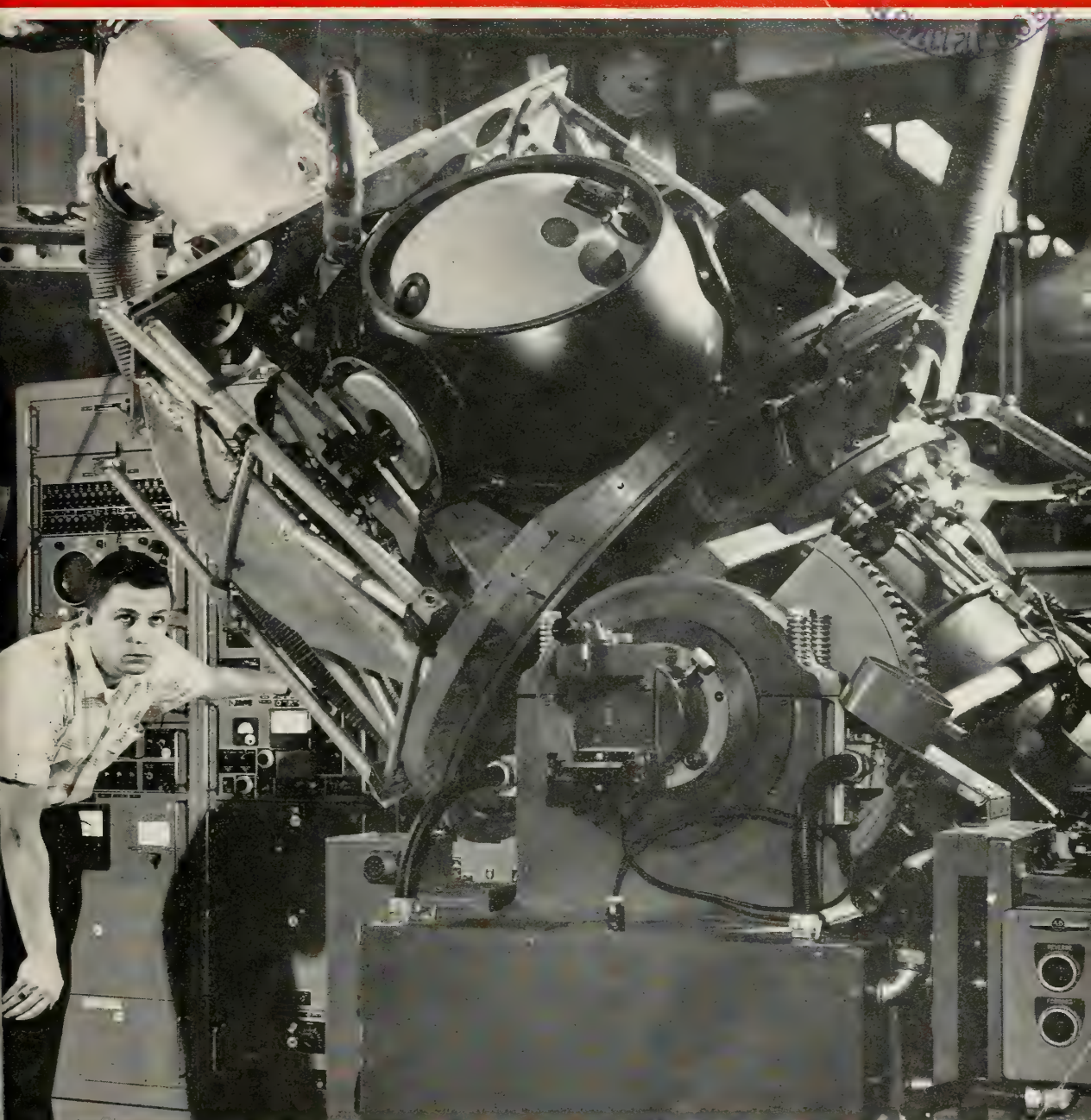
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AUGUST 27, 1962

missiles and rockets

THE WEEKLY OF SPACE SYSTEMS ENGINEERING

AUG 1962



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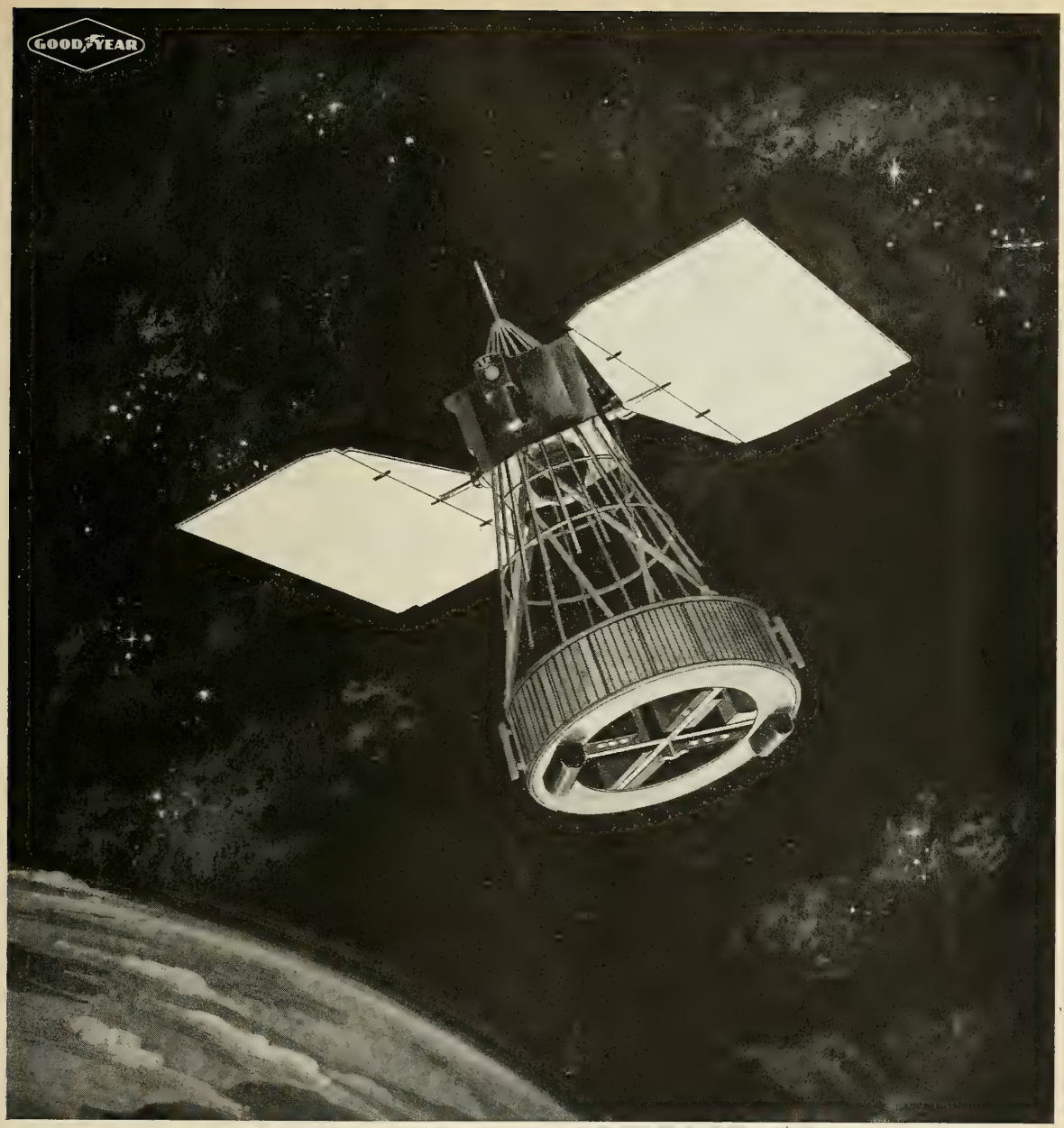
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Yet this panel fabricated by GAC – Goodyear Aircraft Corporation–weighs only 15 pounds.

A pair of them will power Nimbus . . . NASA's Goddard Space Flight Center weather satellite which will orbit 600 miles above the earth. They were fabricated by GAC for RCA's Astro-Electronics Division, developer of the Nimbus power system.

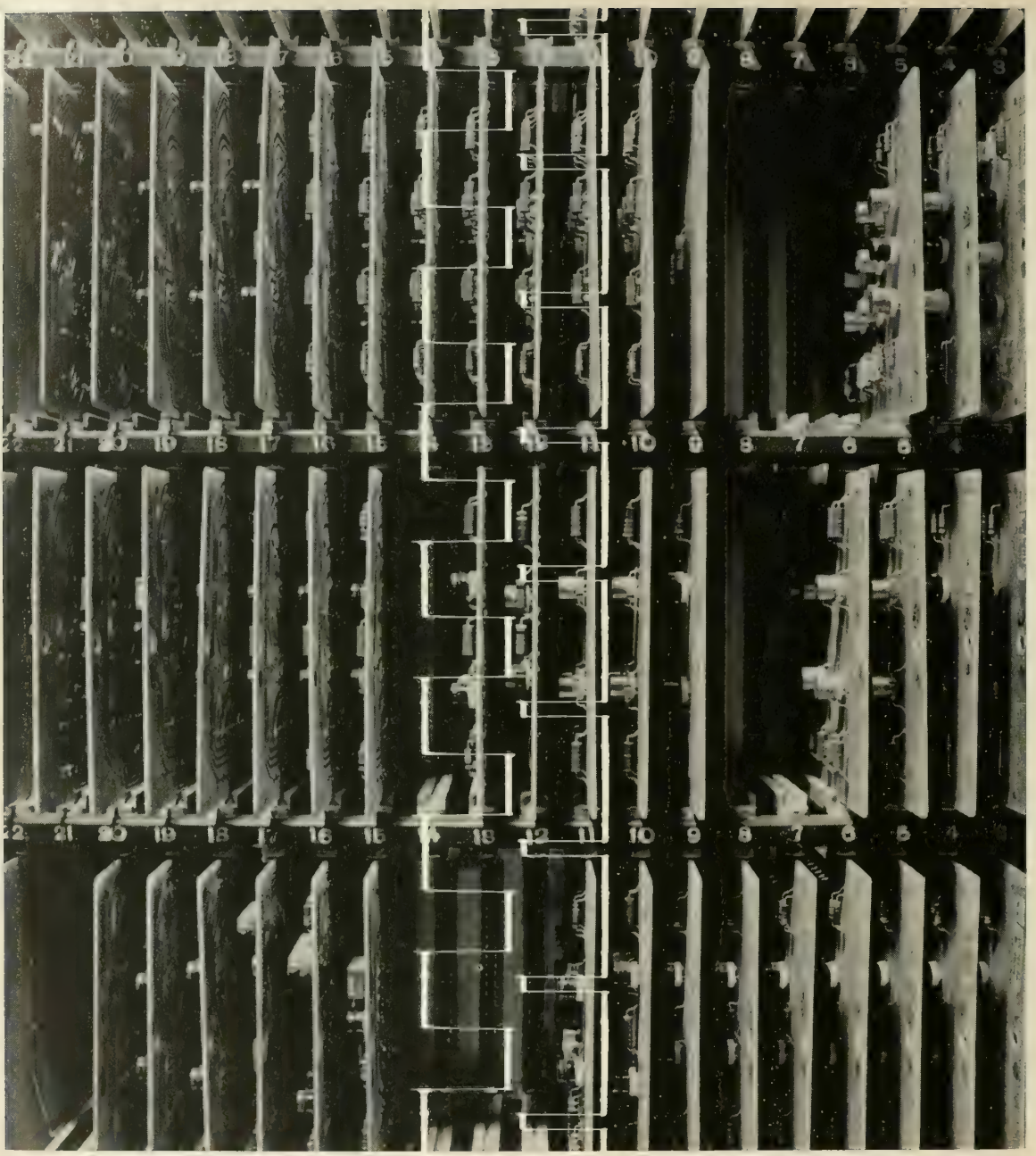
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THE WEEKLY OF SPACE SYSTEMS ENGINEERING

missiles and rockets

Volume 11, Number 9 August 27, 1962

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THE COVER

A modified version of this Titan II all-inertial guidance system will be used in Titan III space booster. System will be developed by AC Spark Plug, rather than first-announced STL/Arma team. See p. 14.



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41,900 copies this issue

Meaning of Vostoks

To the Editor:

The military significance of the Russian manned rendezvous feat *(sic)* should be obvious even to an ostrich (of which there is a plentiful supply). The assumption by some people that the Soviet manned space program is devoted to "peaceful uses of outer space" is sheer idiocy in view of the secrecy surrounding all aspects of Soviet space operations. It is a fact that the U.S. obtains more useful information from its tracking stations than it does from the entire bulk of Soviet "news" releases.

One may now reasonably ask how *MIDAS* and *SAMOS* will fare over the next two years. The answer seems quite obvious. *MIDAS* and *SAMOS* are now almost as obsolete as the U-2. I sincerely hope that those who are responsible for restricting the Air Force's development of manned military space systems have something in mind for the day when operational *MIDAS* and *SAMOS* satellites begin to cease functioning for "unexplained" reasons. With the Soviet manned space rendezvous capability now virtually a fact, by what stretch of the imagination could anyone assume that Khrushchev will allow *SAMOS* and *MIDAS* to continue to operate? The shape of things to come (and soon, too) may be realistically portrayed by a Russian cosmonaut disassembling a *SAMOS* satellite, storing the parts in *Vostok VIII*, and returning them to the Soviet Union. The 64-dollar question follows at once. What if *SAMOS* were manned?

It's time for the U.S. to abandon this "peaceful use of outer space" kick and face up to reality. However, let's not say or do anything to "offend" the Soviet government. Must play the game right, you know.

L. H. Grasshoff
Los Angeles

Phaeton Propulsion

To the Editor:

I would like to obtain clarification and/or references for your statements that "thermic-electrical propulsion is on the order of 20 g's" and "subsequent design goal may be 40 g's" (M/R, May 7, p. 41, and July 30, p. 96, respectively), in your discussion of the French Phaeton satellites.

Does this mean that this satellite vehicle should have 20-40 g boost acceleration on electrically produced thrust? It is my guess that there is a 10^{-6} missing, or else what you really mean is the vehicle is designed to withstand a launch environment of 20-40 g's. Either way the statement is misleading, and I would appreciate it if you would clarify it for me.

Frederick E. Marchand
Development Engineer
Plasmadyne Corp.
Santa Ana, Calif.

The 20 g's figure was provided in the first French announcement. Later, SEPR informed M/R that 40 g's was foreseen in advanced models. We think Reader Marchand's launch environment assumption is correct. We're sending him a copy of "Space Vehicles Powered by Solar Energy," by M. M. Vernet-Lozet and M. G. de Claviere of SEPR, which was presented at the Second European Space Symposium, held in Paris June 18-20. We hope it helps.—Ed.

Sergeant Loses Stripe

To the Editor:

In reference to page 76 of the July 30 (Encyclopedia) issue of MISSILES AND ROCKETS, I must say that somebody goofed!

You made the *Corporal* people very happy, but those of us working on the *Sergeant* system think that M/R went to sleep on that one. The missile you have shown is that of the Army's newest integrated and highly mobile weapons system, the *Sergeant*.

Better luck next time.

Raul A. Garibay
System Branch
Sergeant Division, GMD
Fort Sill, Okla.

To the Editor:

I am an avid space fan and a great fan of M/R. I believe the picture on p. 76 of the July 30 World Missile/Space Encyclopedia issue captioned "*Corporal*" is the Sperry *Sergeant* missile.

I thought you might be interested in the mistake.

The Encyclopedia issue was fabulous.

Lyn Askew
Pittsburgh, Pa.

Quite so. The Sergeant on p. 76 was miscaptioned Corporal. Another Sergeant photo, correctly captioned, appeared on p. 79.—Ed.

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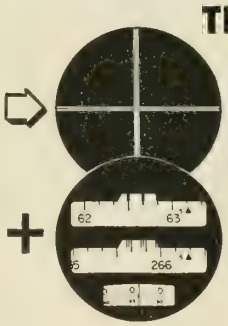
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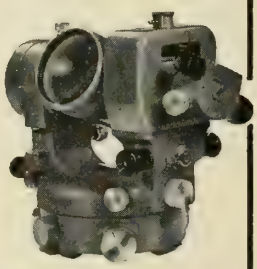


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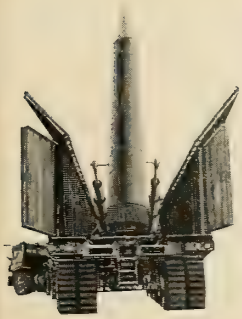
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How to put your finger on precise location

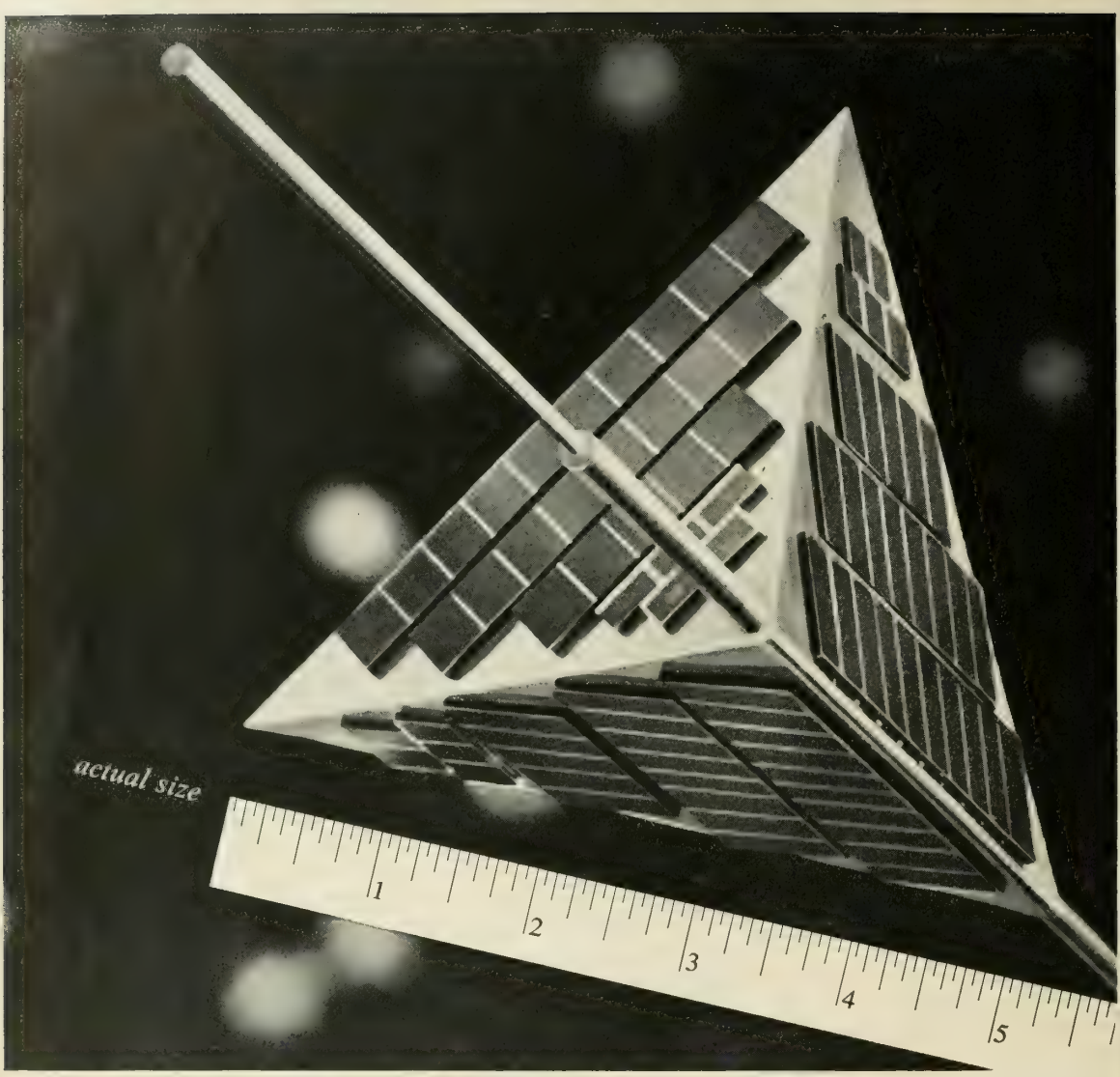


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STL is active on hardware projects such as this and as prime contractor for NASA's OGO and an entirely new series of classified spacecraft for Air Force — ARPA. We continue Systems Management for the Air Force's Atlas, Titan and Minuteman programs. These activities create immediate opportunities in: Space Physics, Radar Systems, Applied Mathematics, Space Communications, Antennas and Microwaves, Analog Computers, Computer Design, Digital Computers, Guidance and Navigation, Electromechanical Devices, Engineering Mechanics, Propulsion Systems, Materials Research. For So. California or Cape Canaveral opportunities, please write Dr. R. C. Potter, Dept. B, One Space Park, Redondo Beach, California, or P. O. Box 4277, Patrick AFB, Florida. STL is an equal opportunity employer.

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The Countdown

WASHINGTON

No Evidence of Docking

There is no evidence whatever that *Vostoks III* and *IV* accomplished rendezvous and docking in orbit. While early data indicated this, it was disproved by later checking. The report has been flatly denied by the Department of Defense and the Soviet cosmonauts themselves.

Recoverable Winged Booster Proposed

Douglas Aircraft has proposed to the Air Force a two-stage recoverable winged booster for an orbital spacecraft. Second stage, similar to *Dyna-Soar,* would carry three astronauts. First stage would carry one man to guide it to a landing.

X-15 Follow-on Program Pushed

North American Aviation is pressing for an extension of the *X-15* program which would increase its usefulness as a space trainer and research vehicle. Proposal to the Air Force covers a ground and sled launch program.

Increased Space Budget Expected

A jump in military space spending is set for next year, even without additional pressure from Congress as a result of the *Vostok* flights. Insiders estimate the military space budget for FY '64 will be close to $3 billion. This means the U.S., with a $5-billion NASA budget, will be spending close to $8 billion on space.

The Ancient Mariner

Next attempt to launch the *Mariner* spacecraft on its Venus journey was set for the early morning hours of Aug. 26. Effects of the new radiation belt (see p. 13) were expected to be minimal.

Titan III Launch Program

Schedule of *Titan III* launches calls for more than 30 a year once the program is well under way. Key to this is extensive use in expanding *Gemini, Dyna-Soar* and *Saint* programs.

Military Strong in Gemini

Military nature of the *Gemini* program is indicated by the close guarding of information concerning the two-man spacecraft. *Apollo* program, by contrast, is wide open.

Is It a Princess?

Red now is passé as a color for alert phones. The red phone in the NORAD combat operations center in Colorado Springs is merely a tactical telephone circuit to NORAD regions and to SAC. Telephone on the hot line to the Joint Chiefs of Staff and to the President is gold.

INDUSTRY

Space Vacuum Is Bettered

For the first time, a space simulation chamber has reached pressures lower than those existing in interplanetary space—going down to 10^{-15} torr and perhaps further. This is 10,000 times lower than that reached by other known simulators. National Research Corp. of Cambridge, Mass., reporting on its development, says the chamber may have reached even deeper vacuums but there are no instruments yet capable of measuring it.

New Step in ML-1 Reactor Program

Coupling of Aerojet-General's ML-1 mobile reactor with a closed-cycle gas turbine generator is scheduled soon at AEC's Idaho facility.

Rubel Speaks at WESCON

Assistant Defense Secretary John Rubel, asked at a WESCON press conference when and under what conditions DOD will be able to specify or define a requirement for military man in space, had this reply: "Many experts have studied this problem for many years. Yet they and we have not yet succeeded in defining a military need for man in space. But this does not mean we have closed our minds or our eyes to the possibility."

INTERNATIONAL

French Missile Ship Commissioned

The French Navy reports commissioning of the escort ship "La Galissonniére," first ship equipped with *Malafon* antisubmarine missiles. The *Malafon,* with a solid-propellant booster, is designed to operate at an altitude of only 600 ft. It is braked by parachute after locating its underwater target with acoustic search equipment.

Trials of British Seacat Completed

Acceptance trials of Britain's *Seacat,* close-range antiaircraft missile produced by Short Brothers and Harland, now have been completed. The missile is scheduled for service with the Royal Navy and has been ordered by Sweden, West Germany, Australia and New Zealand.

English Electric Will Build AS-30

English Electric will build 1000 *AS-30* air-to-ground missiles at Stevenage, England. The French-designed missiles are for the Royal Air Force.

ACCURACY
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GENISCO RATE-OF-TURN TABLES FOR CALIBRATING AND EVALUATING GYROSCOPES AND ACCELEROMETERS

Trajectories into space call for extremely precise guidance components. For accurate calibration and evaluation of rate gyroscopes and accelerometers. Genisco Rate-of-Turn Tables provide the essential precision. Many models and accessories are also available for testing inertial guidance components. More widely used than any other make, the Genisco C-181 Rate-of-Turn Tables are employed by all major companies as their standard for acceptance testing to rigid government requirements. Excellent repeatibility and simplicity of operation make them ideal for large volume production testing. Numerous models and accessories add to inherent versatility of design.

Federal stock numbers have been assigned to the various configurations of the base C-181 model.

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The Missile/Space Week

GE Lunar Bid Is Surprise

Eleven firms have submitted bids for a study contract on NASA's lunar logistics vehicle which will support the lunar expedition. Twelve firms submitted bids for a study of the vehicle's payload.

Firms bidding on the vehicle included: Boeing, Douglas, General Dynamics, General Electric, Hughes Aircraft, Lockheed, Martin, North American, Northrop, Space Technology Laboratories and United Aircraft. Firms bidding for the payload study included: American Machine and Foundry, Bendix Systems Division, General Dynamics, General Motors, Grumman, Hughes, Lockheed, Martin, North American, Northrop, Westinghouse, and RCA.

Contracts for the three-months studies will be awarded in about six weeks. Earlier, officials estimated total development costs of the logistics vehicle and payload at over $500 million. D. Brainerd Holmes, director of NASA's Office of Manned Space Flight, declared recently that the supply vehicle is required by project *Apollo*. It is expected that procurement will be initiated early next year. Two versions of the vehicle will be studied. One using the *Saturn C-1B* launch vehicle and the other, the *Advanced Saturn*.

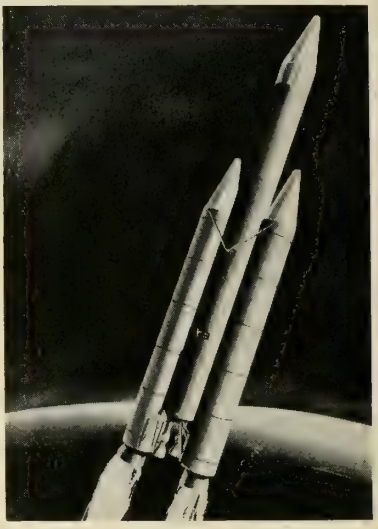
NASA officials were surprised by the General Electric bid. The firm already has a system integration contract for Project *Apollo*. That contract states that because GE is privy to the space agency's future plans, it is not eligible for any other prime or first tier subcontracts. Officials said that while GE can bid on the study contract it apparently is not eligible for it.

Shots of the Week

The automatic yaw control system of the *X-15* failed Aug. 20 while the craft was flying at a speed of 3443 mph and an altitude of 87,000 ft. Pilot was Air Force Maj. Robert Rushworth.

After trying unsuccessfully three times to reset his main control system, Rushworth was forced to complete the flight using the backup emergency control system. It was the second time in less than a week that the yaw control system had failed—the first being Joseph Walker's Aug. 14 flight.

Rushworth's flight was the first high-speed heat rate test of the North American *X-15*. During the high-degree roller coaster maneuvers, the *X-15*'s skin reached temperatures of 1100-1200°F.



Titan III

OFFICIAL AF drawing of Titan III booster (see p. 14) shows close resemblance to models first pictured in M/R July 2.

• A *Polaris A-2* missile blew up only 15 sec. after launch from a land pad at Cape Canaveral Aug. 17, strewing chunks of metal and flaming propellant back onto the Cape. Cause of the first-stage malfunction was not announced.

• A Martin *Pershing* ballistic missile was successfully fired from Cape Canaveral Aug. 21, the Army announced. Fired from its XM 474 mobile transporter-erector-launcher, the flight satisfied all test objectives.

• A *Nike-Cajun* rocket carrying radio absorption experiments was fired from Andoya, Norway, above the Arctic Circle Aug. 18 as part of a cooperative program of ionospheric research between the U.S., Norway and Denmark. It was the first in a series of probes to measure electron density and collision frequency in the ionosphere.

Carpenter Flight Detailed

Erroneous information from the horizon sensors on Cmdr. M. Scott Carpenter's *Mercury* capsule was blamed for the 250-mi. over-shoot of the intended landing area last May 24.

Circle No. 23 on Subscriber Service Card

In a detailed final technical report on the *MA-7* flight presented at NASA's Manned Spaceflight Center at Houston, Tex., last week, scientists said that the incorrect position attitude provided by the sensors would have prevented the braking rockets from firing. Therefore, it was necessary for Carpenter to manually cut out the attitude or positioning device and fire the braking rockets himself. This resulted in a three-second delay which, in turn, contributed significantly to the overshoot.

Carpenter admitted that "the spectacular novelty of the view from space" caused him to make "an unwise expenditure of fuel early in the flight." However, he added, because of this mistake and the resulting drifting flight, he was able to prove that "there was no problem associated with prolonged, drifting flight." This procedure will be used on Walter Schirra's *MA-8* flight, set for next month.

Polaris Sub Launched

The SSBN Alexander Hamilton, the Navy's thirteenth *Polaris*-firing submarine, was launched at Groton, Conn., Aug. 18.

Saturn S-IV Engines Fired

Douglas Aircraft Co. has successfully test-fired a cluster of six RL-7 10 A-3 liquid oxygen-hydrogen engines.

The static test-firing of the engines, which will make up the *S-IV* stage of NASA's *Saturn C-1* launch vehicle, took place Aug. 17.

Lasting 10 sec., the test proved that the cluster of engines can be successfully started and that the engines are compatible with the vehicle propellent feed systems.

The firing was the first in a series of *S-IV* vehicle tests using a heavy-duty "battleship" vehicle. These tests will be followed by similar static firings using a flight-type "all systems" vehicle, and later by a static firing of the first actual flight vehicle before it is transported to Cape Canaveral.

Senate Passes ComSat Bill

The Senate passed the Administration's communications satellite bill Aug. 17 by a 66 to 11 vote, authorizing the creation of a private corporation to develop and operate a *Telstar*-type communication system.

The measure still had to be approved by the House, which earlier passed a slightly different ComSat bill.

Hydro-Space News



Yogi Bear© Hanna-Barbera Productions, Inc.

"Yogi Bear" Bailed Out

A short time ago, a 125-lb bear—destined for immortality in aviation annals—found himself hurtling through the stratosphere at 1060 mph after having been ejected inside a capsule from a B-58 bomber. Minutes later, he and the capsule had floated the nine miles to earth—pressurized, protected and intact—a convincing demonstration of the escape system's efficiency.

Although the shaggy "test pilot" will never know it, he owes much of the credit for his supersonic escape to emergency devices developed and manufactured at Hydro-Space Technology.

Hydro-Space Technology has designed and manufactured a wide variety of cartridge-actuated devices for use in aircraft, missiles and underwater research. They include ballistic gas generators, thrusters, valves, cable cutters and other cartridge-actuated devices. We'll be glad to describe them in full detail and answer any questions you may have. As a start, we suggest you write, on company letterhead, for a copy of our booklet, "Cartridge Actuated Devices & Oceanographic Equipment."

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Circle No. 21 on Subscriber Service Card

Real effort in '65 . . .

NASA/AF Group at Work on ASP Plan

by Hal Taylor

NASA AND THE AIR FORCE have taken the first concrete action leading to development of *Aerospace Plane (ASP)* with the preparation of a joint research program.

The plan is being prepared by a special 30-member ad hoc committee set up last July 20.

Target date for its submission to top management of both agencies is Sept. 1, but it may be delayed for a couple of weeks.

Establishment of the committee and its mission was revealed to MISSILES AND ROCKETS by Dr. Charles Zimmerman, director of the space agency's aeronautical research effort.

The NASA official said the committee's primary objective is the "laying out of a joint hypersonic research program for the next couple of years."

The committee is headed by Lawrence K. Loftis, Assistant Director of NASA's Langley Research Center, and John Bolch, Office of the Director of Advanced Systems planning of the AF Aeronautical Systems Division.

Two primary missions for the *Aerospace Plane,* or the hypersonic aircraft, are being considered.

One is a vehicle system to provide Earth to orbit-and-return capability. The other is an Earth aircraft able to travel 5000 miles without refueling.

Zimmerman declared that it is possible to support a big development effort in Fiscal 1964.

This indicates that the first real development and research effort will begin in Fiscal '65 (M/R, April 23, p. 12).

• **Picking the boss**—Whether or not there will be a joint development program will depend upon a top-level Kennedy Administration decision. One major question to be answered is which agency will have primary responsibility.

It is certain that the Air Force will want to play a leading role because it considers *Aerospace Plane* the first truly operational military space system.

NASA, however, also has a need for the "recoverable booster" capability—one objective of the new program.

Zimmerman said that from NASA's point of view it is a very large program which should be handled in the same general way as the *X-15* research program, an Air Force-NASA-Navy program which was funded by all three.

As far as the *Aerospace Plane* is concerned, he continued, "we would want a lot of funding help from the AF."

Informed sources report that there is already a slight difference of opinion between the two agencies. NASA would prefer the building of a research aircraft; the AF favors going immediately to a prototype of an operational vehicle.

There are also wide differences of opinion among leading space scientists as to just how the plane should be developed. This involves the question of whether it should have one or two stages. Also being considered is the type of propulsion system: rocket, air-breathing or a combination of both.

• **Looking ahead**—These are the sort of things that the two-year research program is designed to answer.

John Stock, Zimmerman's predecessor as director of NASA's Aeronautical Research Program, revealed in testimony before the House Space Committee some of the current thinking.

"Looking to the future," Stock declared, "we see the need for a hypersonic cruise research aircraft to follow *X-15*. The field of application for the technology developed is that of recoverable booster, orbiting vehicle, and hypersonic transport. We understand something of the configuration aerodynamics already, but the simplicity of the configuration hides a most intricate powerplant, and the structure is to a large extent a liquid hydrogen tank because JP fuels cannot be used for Mach numbers much above 5.

"In the Mach 0 to 3 range, the operational mode would be that of a turbofan engine of the most familiar type used with JP fuels or probably hydrogen. For the Mach number range above 3, the type of powerplant would change from a turbofan type to a ramjet, continuing probably to Mach numbers of 8 to 10. During this phase of the operation, oxygen would be collected by piping air from the duct ahead of the burner to a complex system which would liquefy the air, reject the nitrogen, and store the remaining oxygen as liquid in a tank. At the end of the collection cycle and at Mach numbers of the order of 8 to 10, hydrogen and oxygen would be burned in a rocket which would ultimately carry the vehicle to orbital speed. The turboram rocket concept is, in essence, a new engine synthesized from existing technology, but it will represent significant advancement in the state of the art.

"Unique structural features would be involved because the lightweight hydrogen fuels would require large volume. The whole structure itself would have to incorporate such tankage as part of the useful load-carrying structure in order to make the most efficient use of the structural materials and to keep operating weight empty to a minimum. To give continuing focus to this effort, just as the *X-15* gives focus to the opening of the hypersonic regions of flight, we shall require a research aircraft after our studies have advanced a little further. Such a research aircraft would not necessarily have to have a complete multi-orbit capability. . . ." ⌘

AF Recommends Reduced Big-Solid Program

The Air Force has recommended to Dept. of Defense a drastically reduced development program for large solid boosters with an estimated cost of only $80 to $90 million over a 2½ to 3 year period.

The plan calls for static firings of only one and two-segment 156 in. motors and a half-length 260 in. motor, reliable sources report.

The total cost also includes about $10 million for a series of technological developments including case fabrication, nozzle design, thrust vector controls, materials inspection, and a non-destructive inspection system.

Many of these would be tested with firings of the smaller 120 in. solid motor already under contract to United Technology Corp.

DOD officials refused to confirm details of the plan. They indicated an announcement may be made within one or two weeks. It is expected that concurrent with the announcement, DOD will ask for proposals on development of both motors and other required technology.

NASA and the Air Force both supported programs calling for firings of full scale 156 in. and 260 in. motors.

Such a program would have required extensive new facilities for building the motors. DOD rejected the plan and issued orders to the Air Force to come up with a new program which would not require new plants.

Senators complain as . . .

DOD Insists Space Budget Is Adequate

UNDER SHARP ATTACK from Congressional leaders for failure to recognize the military threat posed by the twin flights of *Vostoks III & IV*, Administration officials are sticking to their contention that the Soviet feat was anticipated and does not warrant increased space expenditures.

Russia is substantially ahead of the U.S. in terms of booster capability, Secretary of Defense Robert S. McNamara told a news conference last week. However, he added, the FY '63 budget for space and the FY '64 program now being developed take this lead into account and are geared to overcome the disadvantage. President Kennedy echoed this evaluation at his news conference and predicted that the U.S. would lead before the end of the decade.

McNamara cited approval for development of the *Titan III* space booster as an example of DOD space efforts. He said the new booster will be able to lift payloads far in excess of anything demonstrated by the Soviets to date. *Titan III*, he noted, will have almost three times the thrust of the *Vostok* booster, which American officials commonly credit with an 800,000-lb. thrust.

McNamara was in effect refuting statements by Sens. Barry Goldwater (R-Ariz.) and Howard Cannon (D-Nev.)—both Air Force Reserve generals—that the U.S. space program is neglecting the military potentialities of space.

McNamara pointed out that Administration add-ons to the last Eisenhower budget included a 45% increase for *Dyna-Soar* from $70 million to $100 million, a 100% increase in the *Satellite Inspector* program from $13 million to $27 million, and substantial increases in *MIDAS, Advent, HETS (Hyper-Environmental Test System)* and other programs.

He also noted that FY '63 military space budget was more than twice the FY '61 program and three times that of FY '60. The Defense Secretary said the current U.S. spending of $1.5 billion on military space activities is expected to increase next year; he refused to estimate how much.

Another source indicated that the FY '64 request may jump to about $2.9 billion for military astronautics. One of the principal factors in this rise, of course, will be the heavy funding requirement for *Titan III*.

• **Opposition in Congress**—After issuing a statement through a spokesman that DOD sees no immediate military significance in the *Vostok* flights, McNamara encountered violent reaction from Capitol Hill.

"It would be the most rash and stupid folly," Sen. Cannon said in a speech on the floor of the Senate, "to assume that Soviet space developments have no military applications."

Sen. Goldwater — endorsing Cannon's remarks—asserted that civilian "whiz kids" in the Pentagon are deterring the military from getting into space.

• **Rendezvous story denied**—A report published in *Aviation Week*, a weekly aviation magazine, that the Soviet spaceships rendezvoused and docked was denied by the Secretary of Defense, top NASA officials, the Air Force and the Soviet cosmonauts.

The cosmonauts told a press conference that they had been about five kilometers (three miles) apart at one point during their flights.

The cosmonauts also described the landing system in which they first were ejected in capsules and then, at a lower altitude, ejected themselves from the capsules and parachuted to the ground. They landed 124 miles apart near the town of Karaganda.

Other disclosures by Nikolayev and Popovich included:

—The weight of the latest two *Vostoks* was about 5 metric tons (11,000 lbs.), not much more than the 10,400 lbs. of *Vostoks I & II*.

—*Vostoks III & IV* were more advanced and comfortable than the manned spacecraft of Titov and Gagarin. ⌘

Nuclear Test Fouls U.S. Space Program

THE SENSITIVE timetable of U.S. military and civilian space launches has been disrupted by effects of the new radiation belt created by the U.S. high-altitude nuclear explosion in the Pacific July 9.

The new belt has resulted in accelerated deterioration of exposed solar cells on at least three satellites: *Transit IV, TRAAC* and *Ariel (UK-1)*. AT&T reported unexpected rapid deterioration of solar cells on its *Telstar* communications satellite, but said it could not be definitely determined if this was due to the new belt.

Launching of *ANNA* — the Navy's experimental geodetic satellite system slated for launch two weeks ago—has been postponed until at least Oct. 1. Canada's *S-27 Alouette* satellite, aimed for a 625-mi. circular polar orbit also has been postponed. Its orbit would put the spacecraft almost in the center of the peak electron density.

Timetables for other military and civilian space shots have been pushed back until at least Oct. 1 to avoid the high-energy electron belt which overlaps and extends the inner Van Allen radiation belt to within 200 miles of the Earth's surface at its closest point.

Although NASA is studying the possible effects of the radiation belt on Walter Schirra's *MA-8* flight, Robert Gilruth, Director of the Manned Spacecraft Center, said no difficulty is anticipated from the radiation.

The belt, composed of a peak electron density of 1.5 million electron volts, is centered around the geomagnetic equator at an altitude of some 500 mi. However, its magnetically induced crescent shape brings it to within 200 mi. of Earth at its edges. Four hundred miles deep and 4000 mi. wide, the new belt combines with the inner Van Allen belt at about 700 mi.

The new belt has shifted the center of peak electron density from 16,000 mi. above the Earth to 700 mi. Since the July 9 explosion, the new belt has decreased in intensity by about one-half. At this rate, government officials contend, the belt will soon be dissipated.

Other satellite shots that might have to be postponed include the *S-55B* micrometeoroid satellite, the *S-48* topside sounder, the *S-66* polar ionospheric beacon and *Relay*. Due to their lower orbits or protected solar cells, the *S-6* atmospheric structure satellite, *Telstar II*, and the *S-3A*, a follow on to the *Explorer XII* energetic particle satellite, may still be launched on schedule.

Martin-Marietta prime . . .

AC Will Modify Titan II Guidance for Titan III

AC SPARK PLUG Division of General Motors will modify the *Titan II* all-inertial guidance system for use in the Air Force's new *Titan III*, at least during the early development of the big space booster.

This was one of the few surprises in the August 20 official announcement of the *624A* program, which was signed the previous week by Defense Secretary Robert McNamara (M/R, Aug. 20, p. 10).

In its announcement naming Martin-Marietta Corp. as systems integration contractor for what may eventually be a billion-dollar program, DOD stated that the selection by the Air Force of AC Spark was made ". . . to insure an early operational vehicle."

Previously, it had been announced that a Space Technology Laboratories/American Bosch Arma team had been selected to develop *Titan III's* advanced guidance system. Now, apparently, STL/Arma will be only one of several contractors performing "studies" for the advanced system.

When queried about the reason for the sudden change in plans, a DOD spokesman asserted that the modified *Titan II* guidance would provide an estimated $8-million savings in R&D costs plus a significant reduced-time factor. However, industry informants told M/R that they doubt such a cost advantage, since the *Titan III* missions still will require the highly advanced guidance capability.

"We will continue studies," another DOD official said, "aimed at the development of a more advanced guidance system for later incorporation on a block-change basis to upgrade and further extend the capabilities of the *Titan III*."

Although the STL/Arma combination will study the advanced system, he stressed, they will not be the only one. Nor are they guaranteed a development contract for any such system, he added.

• **"Off-the-shelf" booster**—Officially blessed by DOD now for development, *Titan III* will be the standardized workhorse for a variety of space launchings throughout the next decade. Although program approval actually was given over two weeks ago, the decision was not announced until August 20.

Capable of putting, 5000-25,000-pound payloads into low-Earth orbits, *Titan III*, according to the DOD announcement, "will be able to perform a wide range of manned and unmanned space missions during this decade."

In addition, under an agreement between DOD and NASA, the *Titan III* will become a part of the National Launch Vehicle program.

• **Contractor structure** — Martin-Marietta Corp. was named as the systems integration contractor as well as the firm responsible for airframe modifications to the Air Force's *Titan II* and for the new upper stage structure and control module. Martin has been working on the *Titan III* program since December, 1961, when it received contracts for the program definition phase of the space booster.

Contract negotiations are going on, the announcement said, with United Technology Corp. for development of the 120-in. segmented solid booster engines and with Aerojet-General Corp. for the liquid-fueled engines of the modified *Titan II* first and second stage engines as well as for the engines in the new upper stage.

• **Development plans**—The overall program is funded at approximately $204 million for FY '63. Unofficial estimates put the total development costs of *Titan III* at between $800 million and $1 billion. This would cover development and flight-testing of 17 vehicles—12 core boosters and 5 full-scale *Titan III* vehicles.

Once operational, the booster program may be scheduled for as many as 30 military space launchings a year.

Actual Air Force expenditures for *Titan III* to date have been about $15 million.

In order to reduce launch-pad time and the number of pads required, an Integrated-Transfer-Launch facility will be developed at Cape Canaveral. Here, the *Titan III* will be assembled, checked out and then moved to a simplified launch pad for firing. This concept is essentially the same as that planned by NASA for launch of *Apollo* vehicles.

Designated Program *624A*, *Titan III* consists of five basic parts: the two modified storable liquid propellant stages of the *Titan II*, a new storable liquid propellant upper stage, a control module and a pair of 1-million-pound-thrust, 120-inch, solid-segmented motors. Depending on the mission, *Titan III* can be launched as only the core vehicle (modified *Titan II* minus solid motors) or as a full-size, solids-attached booster.

Although no date has been announced, *Titan III* is expected to be available by late 1964 or early 1965 for initial *X-20 (Dyna-Soar)* launchings.

(For further details of the *Titan III* program, see M/R, May 14, pp. 12 and 35, and Aug. 20, p. 10.)

ARTIST'S conception of integrated transfer-launch facility that will be built at Cape Canaveral to save Titan III launching time. Apollo launch sites will be similar.



Prototypes in 1965-66 . . .

Army Helicopters to Get New Missile Capability



HU-1B helicopter fitted with SS-11 anti-tank missiles.

by James Trainor

THE MISSILE industry is expected to benefit enormously from an almost certain explosive expansion of Army aviation over the next five years.

Although the super-secret Howze Board report on the Army's tactical mobility requirements over the next decade has not yet been submitted to Secretary of Defense Robert S. McNamara, Army officials have evolved a requirement for a completely new and revolutionary helicopter weapons system.

The report also calls for new weapon systems for Army fixed-wing aircraft.

The helicopter, according to Army officials, would provide an armed escort for heavier, slower cargo helicopters and would be armed with yet-to-be-developed missiles—optimized for the escort and ground support missions.

In discussing the new rotary aircraft, these officials cite the experience of the Army Air Force in the early days of aviation when first a single machine gun, and then increasingly heavier loads of aerial weapons, were added to aircraft. It was finally realized that unless both the fighter and cargo (or bomber) aircraft were developed separately, neither could adequately perform its mission.

This is the stage of development of helicopter armament systems now, they say, and this is the reason that, as soon as DOD approves the concepts and programs in the Army Tactical Mobility Requirements Board report, the Army will undertake an aggressive development of the escort weapons system.

• **Escort whirlies**—Although reluctant to discuss the details of the escort helicopter, Army Aviation specialists feel that they can have prototypes of the aircraft available by 1965-66—perhaps sooner with optimum funding. They admit, however, that meeting this schedule requires that they award development contracts for the weapons system during this fiscal year.

Essentially, the escort weapons system will provide "a mobile elevated platform for immediate and continuous fire support in mobile situations." Specifically, the system will be able to screen and protect cargo helicopters from ground fire by suppressing it with organic missiles and rockets. It will also have a capability to fire air-to-air missiles at targets of opportunity.

One of the prime considerations in the development of an escort weapons system is its ability to engage ground targets, eliminate them and then rejoin the convoy. To effectively accomplish this, Army planners say, the helicopter will have to have a "burst" speed of 150-160 mph.

Armament for the escort ship will include machine guns, rockets and advanced missile systems. Of particular interest in the latter category are the systems being developed by the Naval Ordnance Test Station at China Lake, Calif. employing infrared and TV-link guidance.

By 1972, Army planners feel, helicopter weapons systems will employ advanced TV, radar-seeking and infrared-homing missiles. Presently, however, none of these techniques is practical for Army application. Infrared systems, for example, have to be precisely aligned on the target and have very limited range capability, while TV terminal guidance requires line-of-sight for maximum effectiveness. Both, say Army Aviation officials, are inordinately expensive.

• **Armor for all**—Although escort helicopters are likely to open new fields for the aerospace industry, companies will also benefit from the Army's belief that all helicopters must be not only armed but armored.

"It's just a matter of common sense," one Army official pointed out. "You can't ask a man to go into combat with no portection; he may fight—but he sure won't take any chances."

Thus, the Army is just completing a program in South Vietnam to put armor on its helicopters. With this pro-

tection, they say, pilots will be much less vulnerable to small arms fire from the ground. While this is a start, Army officials point out that it really doesn't do the job—armor protection is costly both in weight and performance. What is needed, they say, is some type of lightweight, sandwich armor, perhaps a styrofoam or pressed fiberglass which would dissipate the shock without adding tremendous weight to the aircraft.

An *ad hoc* committee has recently been convened in Washington to survey the problem of helicopter armor and recommend programs and techniques to attack the problem.

• **Equalizers**—On the subject of arming all helicopters with at least light machine guns, and perhaps small rockets, one veteran Army aviator contends that survivability of helicopters in areas like Vietnam depends on their having "a credible threat."

Comparing the situation to that of the light observation airplane of World War II, he points out that the light observation craft—made of fabric and wood and carrying no armament—would have never survived over the battlefield if the enemy had not realized that by firing on it, they were inviting a whole battalion of counter-battery fire. In the same way, he says, if the Viet Cong soldier realizes that by firing at a helicopter he is inviting retaliation, he will be extremely reluctant to do so. By arming these craft, they become a credible threat to the man on the ground, he concludes.

One of the major Army requirements for helicopter armament systems is that they be quickly attached or detached in the field according to the mission to be performed. The philosophy behind this, Army officials say, is that the Army cannot afford to develop one type of helicopter for each mission but must rely on a few to perform a whole spectrum of tasks. With a very small weight penalty for mounting brackets and a stabilization and fire control system, they feel that they can develop rotary-wing aircraft capable of a wide range of weapons systems and yet still able to perform reconnaissance and security missions.

Stabilization systems — particularly yaw stabilization—are one of the most difficult problems still to be solved. At present, for example, the *SS-11*-armed HU-1B helicopter is being held up by the Air Force's Flight Safety certification personnel because of deficiencies in the yaw axis damper. In addition, current stabilization systems are extremely expensive: between $15,000-$16,000 per copy.

The Army is now testing a solid-state augmentation device considerably lighter and less expensive than the ASW-12 autopilot which is causing concern on the HU-1B.

In the area of fire-control systems, the Army is less than satisfied with the optical system used on the HU-1B/*SS-11* weapons system. Essentially a pair of binoculars rigidly mounted on a pipe in front of the co-pilot, the system has two major drawbacks. First, in the event of an accident, the co-pilot risks unnecessary injury because of the rigidly mounted sight; second, the magnification of ground movement causes nausea in the co-pilot/gunner after a few minutes of sighting.

To provide safety for the gunner, the Army is examining the possibility of mounting the optical sight on a hinged bar attached to the side of the helicopter. This would eliminate the hazard while, at the same time, allowing the co-pilot/gunner an unrestricted view when not actually using the sight.

Another development under evaluation is a General Electric sight which reflects a target reticle on a transparent plate in front of the gunner. All of the actual equipment used is mounted behind the gunner. The principle of the device is good, the Army says, but both equipment and display are too large.

• **Fixed-wing armament** — Reluctant to talk about fixed-wing aircraft armament because of the sensitive interface problem with the Air Force, the Army does admit, however, that it is aggressively moving into this area.

The Mohawk Y model, Army officials point out, was produced with hard points for bomb racks and other weapons. And since the Army does not have an officially recognized role in this area or an aircraft engineering test agency, the Navy is testing the weapons system at the Patuxent Naval Air Station with an Army project test pilot assigned to the program.

As part of the Howze Board demonstrations, however, the Army equipped the Mohawk with 2.75-in. rockets, .50 cal. machine gun pods and napalm bombs to demonstrate its effectiveness.



ROCKET LAUNCHERS on HU-1B.

Certain to expand as the result of the Howze Board recommendations, armament for fixed-wing aircraft will center around missiles—both air-to-air and air-to-surface—optimized for the close support missions and slower speeds of Army aircraft.

• **Future needs**—Although the specific needs of the Army's helicopter are likely to mushroom as the result of the Howze Board's recommendations, the following combat developments are already approved and represent official Army requirements:

—Army Helicopter Light Weapons System.

—Army Helicopter Area Weapons System.

—Army Helicopter Point Weapons System.

It is desirable, according to the Army, to incorporate the point and area fire capabilities into one weapons system.

Technical areas of interest include airborne sensors, a means for nullifying enemy electromagnetic radiation, and reduction of infrared radiation from aircraft. The Army is also investigating techniques for adapting aircraft for specialized missions, provision of protective devices for vital parts of the aircraft and crew, and a means of increasing helicopter stability. ⁂

Helicopter Armament Systems

Weapon	Helicopters to Receive Installation	Status
Machine Gun (M37) .30 cal. (2)	H-13 H-23D H-34	Limited production. Kits being modified to receive M-60 MG.
Quad Gun (M-60) MG, 7.62 mm (4)	HU1 H-21 H-34	Engineering test at Aberdeen Proving Ground.
Grenade Launcher XM 138, 40 mm	HU-1B	General Electric Engineer testing at Burlington. Army plans to test at Aberdeen.
2.75 in. Rocket Area Fire System (48)	HU-1B	Undergoing test.
SS-11 Wire Guided Missile	HU-1B	Undergoing flight safety tests at Edwards AFB, Calif.; yaw stabilization difficulties encountered.

Integrated Circuits Dominate Show

Eighty semiconductor exhibits and wealth of multi-element modules evidence competition

by Arthur H. Collins

LOS ANGELES—Semiconductors and integrated solid-state circuits dominated this year's Western Electronic Show and Convention (WESCON).

The more than 80 semiconductor exhibits and the unusually large number of different multi-element modules demonstrated here give some indication of the current intensity of competition, which is steadily driving prices down in this young industry.

Among those showing highly advanced, complex functional circuits were General Electric (a newcomer), Motorola, Fairchild Semiconductor, Pacific Semiconductors, Signetics Corp., Texas Instruments, and Philco-Lansdale.

Coincident with integrated circuit developments was the consensus of WESCON attendees that the market for such components is just beginning to open up. The computer field, for example, is already embracing these new parts. Three major aerospace firms—AC Spark Plug Division of GM, Martin-Denver, and Librascope Div. of GPI—have independently developed advanced space-vehicle computers using Fairchild's Micrologic units. All are high-capacity, high-speed systems in the 20-25-lb. weight class.

Several experts expressed agreement over a growing problem with integrated circuits: while packaging density is increasing, so are power requirements on a relative basis. The result is higher heat and lower reliability. No solution is yet in sight.

Registration during the first two days of the four-day meeting was well above estimates. It was expected that more than 50,000 persons would attend, according to conference officials.

• **Mark Twain beaconry**—Soft lunar landings by manned vehicles will depend in part on the ability of crews to make distance measurements in a new set of operational circumstances. These measurements must be made rapidly and accurately over large dynamic ranges of velocity and altitude, W. E. Muntz, of the Light Military Electronics Dept. of the General Electric Co., noted during his description of the new "Mark Twain" beacon system.

In considering the advantages of radio beaconry and the requirements of a spacecraft-contained measurement technique, it became apparent, said Muntz, that a phase-locked oscillator beacon could be launched from the spacecraft. Its velocity increment would be sufficient to cause it to impact on the Moon before the spacecraft arrived at the million-foot altitude.

This impact, Muntz claimed, would destroy the beacon but would also signal the time to read the Doppler count.

Doppler cycle-counting is the basic technical principle of the system, requiring that the rate of change in range between the beacon and the spacecraft be continuously sensed by detecting the total Doppler shift between the spacecraft and the beacon transmission. Integration of this rate, he said, results in the desired range.

The range to the beacon is continuously obtained by properly scaling the total Doppler cycle count. The range to the lunar surface is then the last count received, since transmission from the beacon ceases the instant that it is destroyed on impact.

• **Space watch urged**—A large-scale attempt to detect signals beamed from the vicinity of stars 1000 or more light years distant was urged by Morris Handelsman of RCA.



UNVEILED AT WESCON show was this sample of work of Aerojet's new Microwelder. Two wires .0005 in. thick are welded to a .001-in.-wide metal deposit.

Handelsman, of RCA's Advanced Military Systems Group, cited an analysis which indicated that chances of detecting signals from stars within tens of light years' range is very small because of the small sample. Based on a number of factors affecting the possibility of technically advanced intelligence near other stars, he stated, the probability of communicating life existing near any star in our galaxy has an upper bound of 0.02 and a lower bound of 0.000001.

Noting that Project Ozma ended after only a 150-hour search of several nearby stars, Handelsman urged resumption of the search by available radioastronomy antennas, plus an analysis of system configuration, cost and appropriate R&D in order "to be more fully prepared for a decision concerning a large-scale effort."

To receive a signal from at least one civilization within 1000 light years, he said, it was estimated that examination of some 200,000 likely stars in a field of about 10 million stars is required. Handelsman said analysis indicated a long-term, large-scale effort with a noncoherent type receiver and a huge antenna "is within the bounds of reason, technical capability and cost." ⁂

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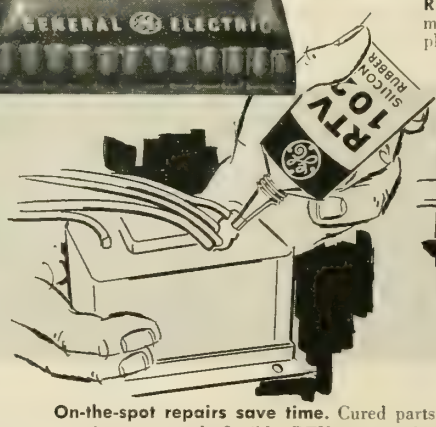


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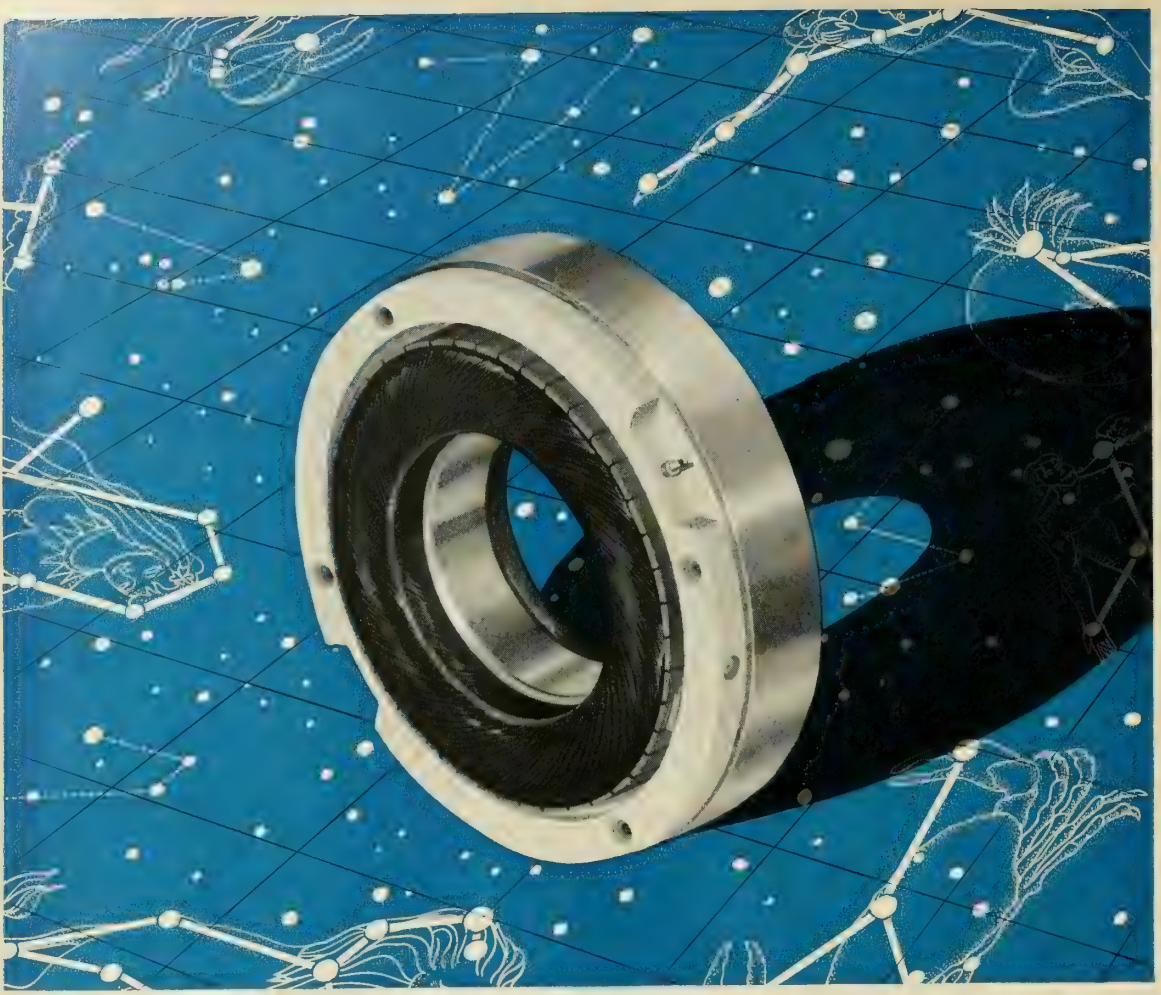
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Technical Countdown

ELECTRONICS

SATAN Contractors Selected

Initial contracts totaling roughly $2.5 million will be awarded by NASA for the *SATAN* satellite acquisition radar receiving system to Dalmo-Victor Co. and Amelco, Inc., both located in California. Splitting the total award equally, the firms will develop 10 Satellite Automatic Tracking Antenna systems. Dalmo will build the antennas; Amelco will build the advanced receiving system; NASA developed the original design criteria. *SATAN* will significantly improve the efficiency of the existing global Minitrack network, according to officials at Goddard Space Flight Center.

World's Most Powerful Computer Tested

The prototype Ferranti Atlas, one of the world's most powerful computers, is now nearing completion at Manchester University. A pilot model incorporating some of the major units of Atlas began test operation at the University in October, 1960; since then, the main storage and control unit have been added. Lengthy tests reportedly have produced results that exceeded expectation. Ferranti Ltd. reports it has many orders on hand for other custom-built Atlas computers including one for the National Institute for Research in Nuclear Science, Harwell, which will cost about $10 million and another for London University at approximately $5½ million.

Production Line Functional Circuits?

A low-cost, short-cycle, high-yield method for producing multi-circuit microelectronics on a single wafer has been devised by General Electric's Semiconductor Products Department. The technique is based on the use of functional blocks composed from a general purpose matrix of isolated transistors and resistors on a 1-in. silicon wafer. Circuits are formed by selective deposition of aluminum interconnections among the various elements. Seven different functional components are now available to industry for evaluation said a GE spokesman.

D-Layer May Monitor Nuclear Explosions

Nuclear explosions in space may alter the energy patterns in the D-layer of the ionosphere, thereby laying a possible groundwork for detection. Navy nuclear experts believe the explosion effects will be registered on the phase of very low frequency signals spreading over varying distances and locations. For comparison on a long time basis, measurements of phase fluctuations will be obtained diurnally.

60-ft. Radar to Study Missile Signatures

Some details of the new Air Force radar system RAMPART (Radar Advanced Measurements Program for Analysis of Reentry Techniques), released last week by Raytheon, the system developer, give some indication of the severe requirements necessary to achieve target discrimination. The system is due to be installed for testing at White Sands Missile Range early next year. RAMPART statistics are impressive: The 60-ft. dia. dish antenna will stand on a 95-ton pedestal and will radiate a pencil beam with peak power of 24 megawatts; high speed tracking and data processing units will handle about 100 "radar-signature" measurements per second. Under the $4.3 million contract, Raytheon and Fairchild Stratos designed the antenna; McKiernan-Terry Corp. built the pedestal.

ASTRONAUTICS

Ionosphere Tests Continue at Woomera

A *Skylark* rocket fired to a height of 78 miles from Woomera on August 15 carried a Phillips vacuum gauge which measured pressures above 60 miles. Properties of the ionosphere between 40 and 50 miles were also measured by instruments installed by Sheffield University and University College (University of London). All experiments were reported successful.

Low-Drag Designs Simplified

Minimum drag shapes of missile bodies and supersonic inlets can now be computed with a remarkably "simple" mathematical technique devised by scientists attached to the Aeronautical Research Laboratories at Wright-Patterson AFB, Ohio. Assumptions made in the analysis are said to be close enough to technical reality to make the results immediately useful in engineering problems. Underlying theory is in ARL Technical Report 62-342.

Advanced Surveyors Described

Alternate payloads for *Surveyor* include a mechanism to return a lunar sample to Earth, and a roving vehicle to explore the Moon's surface, a National Aeronautics and Space Administration official disclosed last week. Two additional capabilities *Surveyor* does not have, chiefly because of weight restrictions, are the ability to land anywhere and to hover. These may also come about when the *Saturn* booster is operational, said Oran Nicks, NASA's director of lunar and planetary programs.

ADVANCED MATERIALS

Single Crystals Cut Without Stress

Electro-erosion equipment and techniques have been developed by Metals Research Ltd., Cambridge, England, that shape single metal crystals without inducing stresses and strains. Currently marketed as Servomet, a machine intended primarily for metallographic preparation, the principle can be applied to semiconductor production. A dc spark discharge passes between an electrode and the workpiece immersed in paraffin. The electrode and crystal are kept about 0.0015 in. apart by a sensitive servomechanism controlled through an amplifier by the breakdown voltage itself. This eliminates electrode contact, which is believed to be the principal cause for thermal and mechanical damage in ordinary spark machining.

Semiconductors Studied by Improved Method

An advanced research technique for analyzing semiconductor materials may lead to the production of lead telluride exhibiting improved mechanical and electrical properties. Developed at the Naval Ordnance Laboratory, the method combines into one simple operation the two separate steps of polishing and etching new crystals for evaluation. Thus, crystals are not exposed to air between the two processes which are performed at room temperature. Advantages: no film forms on the crystal surface; no crystal cracking from thermal shock.



Moon May Now Be Contaminated

Sterilization of Lunik II, Ranger IV was incomplete, VPI meeting is told

by William Beller

BLACKSBURG, VA.—Man may have already contaminated the Moon through the impact landings of *Lunik II* and *Ranger IV*.

Carrying hitch-hiking microorganisms in rocket fuel and sealed components, the spacecraft may have unleased living bodies onto the lunar surface. Dropping through cracks and crevices there, the microorganisms may be proliferating in the lunar sub-surface, possibly killing man's hope to explore a virgin Moon.

This was one of the few points on which lunar experts agreed during a week-long meeting here. Frequent clashes among noted scientists defending their theories punctuated the Aug. 13-17 Conference on Lunar Exploration at Virginia Polytechnic Institute.

The National Science Foundation and the Langley Research Center of the National Aeronautics and Space Administration joined VPI in sponsoring the conference.

Asst. Professor Carl Sagan of the University of California's Astronomical Dept. warned against contaminating the Moon with microorganisms from Earth, or Earth with microorganisms from the Moon. Possibility of finding residues of life on the Moon is small, he pointed out, but has a potential of high yield.

He said some harm may have already been done: although the Russians cleansed the exterior of *Lunik II* with steam and formaldehyde before it impacted the Moon on Sept. 13, 1959, the spacecraft's interior contained terrestrial organisms which could have been released.

The U.S. also may have innoculated the Moon with live organisms when *Ranger IV* impacted April 26, Sagan said. These may have migrated from the rocket fuel that did not ignite.

• **The dissidents**—A measure of the degree of ignorance about the Moon was echoed in a conference complaint by Dr. Harold Urey: "All explanations for the origin of the Moon are highly improbable."

Nevertheless, the Nobel-prize winning scientist joined with other leading lunar lights in favor of the "hot" Moon theory. This is a concept that the lunar body was at one time a molten mass. Dr. Urey in taking this stand retreated from a view he has held for a long time: the Moon was formed and remained relatively cold throughout its being.

Evidence purportedly backing theories about the origin and character of lunar phenomena marked many of the papers and discussions: Jack Green, geologist from North American Aviation, Inc., admitting he was filing a minority report, maintained that lunar features were caused chiefly by volcanic action, not by meteoritic impacts.

Zderek Kopal held that the so-called lunar bulge on the near side of the Moon is distinguished more by poor observational data than by fact. Kopal is head of the department of physics and astronomy at the University of Manchester, England. He is also deeply involved in an Air Force program to help furnish data for the mapping of the Moon.

The question of the origin of tektites—dark, glassy objects, mainly silica—caused the most turmoil. Dr. Urey challenged scientists who say tektites come from the Moon to explain why they are found only in southeast Asia and Australia.

He also asked how they first got off the Moon—about 1000 tons worth, according to estimates. A rebuttal was that meteoritic impacts knocked them off. A remark heard by part of the audience was that tektities are known by other names and indeed are found scattered throughout the world. But this observation never reached the conference floor for discussion.

• **An updated theory** — An early highlight was Dr. Ralph Baldwin's graphic concept of the origin and development of the Moon.

Trained as a professional astronomer but now working as a businessman for Oliver Machinery Co., Baldwin wrote a book about the Moon that awakened Urey's interest in the lunar field—*The Face of the Moon,* published by the University of Chicago Press.

Baldwin maintains that the theory is wrong that the lavas in the lunar lowlands were formed by meteorites and planetesimals impacting the Moon and cratering it. He pointed out that exhaustive tests made by experimenters to stimulate such impacts resulted chiefly in splattering and granulating target materials and only incidental melting—

far too little to bear out a liquid-lava theory.

He concluded that the Moon's craters and maria were formed in a dry condition and that lava flow was a separate phenomenon.

He said that the lavas issued out of the body of the Moon at a time long after the circular maria craters were produced and nearly at the end of the major period of impact of meteorites with the Moon's surface.

• **Hot Moon**—To support his theory, Baldwin hypothesized a hot Moon. He said that energy from various sources could have raised the Moon's temperature during the body's early life: radioactive nuclides, probably most effective in heating the center of the Moon; the Sun, which may have been much brighter than today's; adiabatic compression of the lunar material; chemical reactions; and the velocity of infalling bodies.

Baldwin said the addition of these energies must have resulted in a completely melted Moon early in the body's history—except perhaps for a scum of sintered material floating on the surface. He said that subsequently the Moon was cooled by convective currents transferring heat from the lunar interior to the surface and then to space.

Within a few thousand years the Moon would have become solid except possibly for a liquid iron core, according to Baldwin. Nevertheless, the Moon would have still been hot, he said: the temperature at various depths would have been slightly less than the freezing points of the various residing silicates.

He suggested that the large molecules containing the long-lived nuclides of uranium and thorium and—to a lesser extent—potassium, would have been selectively transported into the upper half of the Moon's mantle.

In Baldwin's model, the Moon for a long period of time absorbed meteoric impact by isostatic adjustments of its mantle; later, as surface cooling reached greater depths, new craters were less deformed; still later, the Moon's crust became sufficiently strong and deep to register the tremendous impacts of the bodies that produced the circular maria.

Just before the lavas came, many craters were produced over the lunar surface, some inside the dry circular maria, Baldwin said. Small isostatic adjustments were continuing; the outer layers were becoming cooler and more rigid. At the same time, the deep lower layers where the long-lived nuclides were concentrated were becoming warmer. He judged that the entire region about



DETERMINING the heights of lunar mountains by measuring the length of shadows cast by the peaks.

200 to 300 miles below the Moon's surface was probably hotter than 1400°K.

The Moon began to expand despite its rigid crust. Giant cracks occurred, down to the heat-rich magmas. The hot lavas belched through the cracks, spreading over the lunar lowlands. Baldwin said that vast areas were covered to depths of thousands of feet. Many lava flows were involved, at different places at different times and of different compositions. Baldwin claimed there is sufficient evidence to show that the lavas advanced and retreated many times—until the Moon's present character was developed.

• **Other Theories**—Dr. Urey agreed with Baldwin that much of the Moon's interior heat is contributed by the energy of fission of long-lived nuclides. Urey also said that a hot Moon could account for the C_2 spectrum that the Russian scientist N. A. Kosyrev reportedly obtained during an observation of the central peak of Alphonsus in 1958. It would be the result of the chemical decomposition of sub-surface materials.

Unlike Baldwin, Urey maintained that most of the lunar features were formed at the time of the origin of the solar system—4.5 to 4.7 billion years ago.

Dr. Kopal took sharp issue with scientists believing that the Moon has a permanent bulge in the direction of Earth. Said to be caused by the pull of



AF cartographers check a continuing stream of lunar photographs to construct a controlled mosaic of the Moon.

Earth's gravity, the bulge is estimated to be 6500 feet high. Kopal argued there is absolutely no proof the bulge exists: to be able to measure it—if it is present—would call for a telescope able to measure an arc of 0.1 seconds, which cannot be done at this time.

Kopal also hypothesized a mechanism presumably able to heat the Moon sufficiently to raise its internal temperature of the order of 1000°C. He assumed that the Moon is a visco-elastic body. Then the Earth-induced ties on the Moon—the breathing in and out of the body's mantle—brought in by the eccentricity of the lunar orbit would be able to generate the energy needed to appreciably heat the lunar interior.

• **Life on the Moon**—Sagan made a strong plea for sterilizing all spacecraft sent to a landing on the Moon. Even the outer garments worn by astronauts landing on the Moon should be made sterile, Sagan indicated.

Admittedly ultraviolet radiations from the Sun will kill microorganisms. But Sagan's worry is that if care is not taken some of the microorganisms from an unsterile body such as a spacecraft interior will escape and slip through crevices and pockets on the Moon's surface. Shaded from the ultraviolet, living in a moderate temperature, conceivably having access to water, and probably having no natural enemies to stop them, the microorganisms could proliferate.

Sagan saw three, possibly four, sources of life for the Moon. First, the Moon could have spawned life the same way the Earth is presumed to have done. Next, organic matter present in the original solar nebula may have survived the accretion process that some scientists say led to the Moon's formation; life could have arisen from such matter.

A third proposed source is from carbonaceous chondrites which contain a fair proportion of organic matter. A mitigating factor is that the source of these chondrites may be the Moon itself.

The fourth possibility is that the Earth when hit by meteorites may spray organic matter into space and from there onto the Moon.

• **Astronauts a menace**—Sagan said there is a chance that *Apollo* astronauts may be carriers for lunar microorganisms. Urging that the danger be realized, Sagan noted precedents when the Earth was explored: the virulence of measles carried to the Polynesians, and of tuberculosis taken to the North American Indians.

The moral is to make sure that the returning lunar team is thoroughly decontaminated, Sagan said.

The Moon's southern highlands are probably the best place to seek organic molecules and microorganisms, Sagan



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believes. He suggests digging down about 10 meters to find them—or making the search in craters where such holes already exist.

He explained that meteoritic impact probably charred and destroyed any organic matter that ever existed close to the Moon's surface. Moreover, lava flows in the maria undoubtedly obliterated any organic matter that was there.

Sagan considers the search for life on the Moon to be one of high risk but also, if successful, of high yield. He says that it is not necessarily true that the lunar environment is hostile to life.

Conditions a few meters below the Moon's surface possibly would be just right for replication of terrestrial life. There would be layers where organic molecules would exist and organisms multiply.

Life on the Moon could have begun the same way it did on Earth, Sagan said. The original body was first enveloped in a reducing atmosphere. Energy was added to this atmosphere, probably most of it by ultraviolet solar radiations.

Chemical reactions occurred resulting in the formation of organic molecules such as purines, pyrindines and deoxyribose. These rained down through the Earth's atmosphere, over the land and into the oceans. At the same time, the atmosphere was changing to an oxidizing one.

Meanwhile in the oceans, primitive nucleic acid was being formed out of the organic molecules. It catalyzed nearby molecules of newly formed nucleic acid thereby bringing about the first self-repliations. From here, there is no scientific difficulty in relating the evolution of man, Sagan said.

He observed that in early times oxygen was a poison to living organisms, but they learned to live with it, even use it.

• **Before man goes**—Shortly, some of the theories about the Moon are expected to be verified or disproved by data furnished by unmanned lunar landers. *Ranger V* in mid-October will carry instruments to detect the presence of uranium, thorium or radioactive potassium. Their readings may indicate whether long-lived radioisotopes are in fact heating up the Moon's interior.

Surveyor flights starting in 1964 are expected to furnish additional data about the Moon's interior and, moreover, televise detailed pictures of the Moon's terrain.

These efforts may lead to a quick answer to the highly disputed question about how the Moon was formed. Many experts believe, however, that only man poking around with geologists' picks will be able to resolve fundamental questions about the lunar body. ⁂

Two-Man Lunar Craft Is Doubtful

NASA's Holmes says use of vehicle would delay program; Gilruth outlines Apollo details at Seattle meeting of IAS

D. BRAINARD HOLMES, director of NASA's Office of Manned Space Flight, has serious doubts as to the advisability of using a direct flight two-man spacecraft for the first U.S. lunar landing.

Holmes told a press conference that substitution of the two-man vehicle would mean that the current target date for landing on the Moon would be delayed.

He said one solution would be to use cryogenic propulsion systems for the two-man craft, "but this scares me."

Holmes' comments were made at the conference on lunar exploration held in Blacksburg, Va.

While NASA has already selected Lunar Orbit Rendezvous for the first U.S. manned lunar landing flight, it is still studying direct flight with a two-man vehicle as a possible alternative if LOR proves infeasible.

Holmes made it clear that even if an immediate start was made on a two-man spacecraft, it could not compete with the time schedule for LOR.

In other important comments on Project *Apollo,* Holmes said that:

- Detailed scheduling and cost estimates for the lunar landing program will be ready in two months.
- NASA has no funds right now for a space station program, but some money might be made available for it in Fiscal 1964.
- A Lunar Logistics Vehicle is absolutely necessary to support any lunar landing mission.

- **One-day stay**—The lunar exploration module of the *Apollo* spacecraft will have a capability of sustaining man for four days. The first U.S. astronauts to land on the Moon will stay only one day.

Meanwhile, details of NASA's three man *Apollo* spacecraft were revealed in a paper presented at the Institute of Aerospace Sciences Man-Machine Competition meeting in Seattle, Washington.

The paper, "Man's Role in *Apollo*", was written by Robert R. Gilruth, director of the space agency's Manned Spacecraft Center.

Gilruth said that the spacecraft's command module pressure cabin will have a volume of approximately 365 cu. ft. After subtracting equipment volume, some 220 cu. ft. of free space remains available to the crew.

"The small end of the command module may contain an airlock; when the lunar excursion module is not attached, the airlock would permit a pressure-suited crewman to exit to free space without decompressing the cabin. Crew ingress and egress while on Earth will be through a hatch in the side of the command module," Gilruth said.

- **Side-by-side**—During Earth launch and re-entry the crew is seated in three side-by-side couches. During other flight phases, the center couch is removed to create a "center aisle" and permit the crew more freedom of movement. The couches also contain adjustments to permit variation of body angles for comfort during non-acceleration mission phases. The couches are mounted on shock struts to provide omni-directional attenuation of Earth landing impact accelerations.

During non-acceleration phases of the mission, the center couch is stowed under one of the outboard couches and serves as a bed.

The crew will wear pressure suits during Earth launch, re-entry, and during operations in the lunar excursion module. The command module environmental system is being designed to maintain cabin pressure after certain types of cabin punctures for sufficient time to permit the crew to don suits.

The *Apollo* command module has five windows: a general observation window in the entrance hatch; two forward rendezvous windows; and two side windows for general observation, horizon reference and Earth landing reference. The command module windows are supplemented by a scanning telescope which is part of the navigation system; the telescope can be adjusted and rotated to provide an extensive field of view on the side of the command module opposite the windows.

- **Control panel** — During Earth launch and Earth re-entry, all three crewmen will be stationed at the main control panel. The panel and adjacent consoles have a display area of approximately 2000 square inches. Primary flight controls and displays are at the left; systems management displays are to the right. A partial set of duplicate flight controls will be located in the center or at the right side of the main panel. During coasting phases of flight, the on-duty crewman will stand his watch at the systems management station.

Behind the main instrument panel will be a checkout panel. This panel contains test points and instruments for use during preflight and inflight checkout and various displays not needed during critical mission phases.

The navigation station, containing a sextant, telescope, computer, and associated displays and controls, is located at the foot of the center couch which will normally be unoccupied or stowed when the station is in use. ⁂

Surveyor Testing

LANDING TESTS for NASA's *Surveyor* lunar vehicle will be conducted at White Sands, N.M., late this fall.

The test vehicle will be dropped from a balloon at high altitude and descend by parachute to simulate the lunar gravitation field. The White Sands tests will be for primary purpose of checkout of the *Surveyor* vernier engines for "soft" landing velocity control.

Tests are still being carried out by Hughes Aircraft Co. — prime contractor for *Surveyor* — at its company's Tucson, Ariz., facility, where the *Surveyor* landing gear will be built. Construction of the first "production" landing gear is now under way.

The prototype gear is being tested in a lunar surface simulator which is capable of "reducing" the vehicle's weight by five-sixths without changing the total mass.

Hughes engineers, borrowing from aircraft drop-testing techniques, came up with a system which is relatively massless, but provides a lifting force which remains constant and vertical regardless of the vehicle's horizontal or vertical motion.

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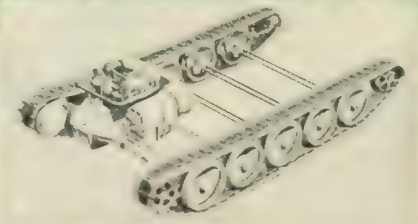
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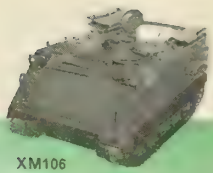
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THE M113 BY FMC
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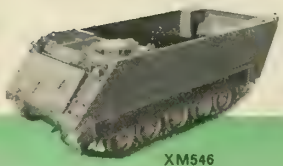




This basic engine, power train, and torsion bar suspension system is common to the M113 and to all members of the vehicle family, thus minimizing manufacturing cost and field maintenance problems.



XM106



XM546



AN/TPS-25



Mercury Recovery Vehicle

XM106 Mortar Carrier. Built for 81 mm/4.2-inch Self-Propelled Mortar. Retains basic M113 silhouette, changing only hatch doors and interior arrangement.

XM546 Mauler Vehicle. Designed to provide full mobility to the Mauler system. FMC, under separate contract, also supplies the launching pod assembly.

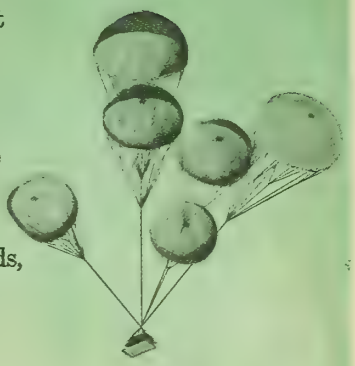
AN/TPS-25 Radar Carrier. Basic vehicle adapted to provide armored transport for sensitive radar and communications equipment over rough terrain.

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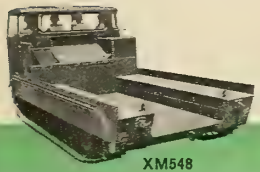




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XM548



XM474

XM548 Cargo Tractor. Adaptation of unarmored M113 which provides space for a driver and three additional personnel. This cargo version has numerous potential supply and re-supply applications.

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Avco Develops 3-D Space Tracker

Electroluminescent grid panel is heart of new multiple target display system

by Charles D. LaFond

CINCINNATI — Electroluminescent two- and three-dimensional display systems are now believed to have been developed to the point where they can be used effectively to monitor and assist in the control of spacecraft.

Such instruments, which have been under R&D by Avco Electronics and Ordnance Division here for over two years, could fulfill the need at ground control stations for rapid assessment of complex vehicular situations in space.

With a 3-D approach, it is possible to continuously insert tracking and ranging data of multiple targets and present them in their true spatial perspective. Flat-screen or 2-D displays can be used independently or as a supplement to the 3-D equipment.

A feasibility model of the 3-D display was first described by Avco's J. L. Coddington and R. J. Schipper at the Institute of Radio Engineers' Annual Conference and Exhibition in New York City last March. The model drew widespread interest as a partial solution to the problem of aircraft control.

As development of the system progressed, it became more and more evident to Avco engineers that such a system offers an even greater potential in the missile/space field.

Coddington, who was a project engineer in charge of early R&D for the 3-D display and is now assistant marketing manager for Radar and Systems, recently described for M/R his company's case for these new display approaches.

• **3-D display principles**—Basically, he said, Avco's 3-D display consists of an electroluminescent, cross-grid, nonsuppressed matrix panel. Mounted upright and bisected by a vertical axis, the panel is rotated about the center shaft by a rigidly supported 1200-rpm motor beneath.

A light spot on the grid can be generated by energizing any given horizontal and vertical line. At the point of intersection, a bright spot is illuminated which is two-dimensional. By rotating the panel at a speed above flicker rate and by electronically pulse-gating the panel (to achieve azimuth from the center shaft position), a spot or target can be made which appears to float freely in space.

Thus, said Coddington, if varying (x, y, z,) values were to be generated



3-D DISPLAY is shown being operated by system developer, John L. Coddington, at Avco Electronics and Ordnance Div. Targets float at point of intersection of nonsupported grids on a rotating electroluminescent screen. Ten targets are possible; color can be introduced with two EL panels.



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and fed into the display from external sensors, such as radars, the relative location and movements of a series of targets could be shown three-dimensionally by the display. With computer control, a "fourth dimension"—time—may be included such that both the previous flight paths and predicted paths (or trajectories) are generated, possibly in a different color.

This form of display, he stresses, is qualitative, permitting the rapid assessment of a dynamic situation. However, there is no reason, according to Avco designers, why quantitative data could not also be displayed on command from an associated computer and displayed on other co-located alpha-numeric indicators. They say supplemental readout information would be tailored to each application requirement.

• **The EL panel**—Through the use of an electroluminescent (EL) panel, the conversion of electrical energy into light is direct. EL panels, now commercially available, consist of (1) a glass base sheet which serves as the mechanically rigid structural member and as the foundation for (2) a transparent conductive film, (3) a ceramic dielectric with an EL phosphor, and (4), another layer of the transparent conductive film. The panel is effectively a large capacitor with the two film layers or "plates" separated by a dielectric, since electrical connections are made to each film layer.

To effect a cross-grid pattern, the film is laid down in strips—vertical lines extend from the horizontal axis (for range) and horizontal lines extend outward from the vertical axis (for height). The two panel halves are divided into odd and even height lines, since a non-suppressed grid is employed to achieve a bright dot at each intersection.

In the Avco demonstration model, the EL panel measures 10 in. wide (the diameter) by 11 in. high. A 1-in. vertical strip down the center is used to drop the electrical connections for height determination. Those for range data insertion run inward across the bottom edge of the panel to the center.

The panel is supported by a split shaft attached to a bearing housing at the top of the protective plexiglass dome and to a coupler on the bottom. The coupler is attached to a 100-element slip-ring assembly shaft and shaft-angle position encoder. The whole assembly is rigidly supported in a vertical plane.

• **Display controls** — Avco's first model was designed as a demonstration tool, Coddington said. Thus, rather than extending system sophistication to the point of accepting inputs from external sensors, the instrument employs a self-contained simulator within the display console.

A solid-state automatic simulator is now in final development and is expected to be ready for operation in September. It employs a magnetic core memory and will permit the simultaneous display of up to 10 targets, Coddington said. Again for purposes of economy and simplicity in designing the new demonstration system, targets will be fixed in space. Although they will be moved about to assume new fixed spatial positions, no attempt has been made to simulate continuous motion with the new equipment.

Engineers here believe they have shown feasibility of their approach to three-dimensional display. They hasten to add, however, that many modifications could be made to further enhance the present system.

For example, the prototype uses a transparent domed or bell-jar cover, which tends to create some light distortion. This could readily be changed to a cylindrical cover with a flat, clear top.

Also, the present unit must be operated in a darkened room. Target intensity could be increased considerably,

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the engineers assert, by duplication of the spot on each panel half, so that it would be illuminated twice in each full panel revolution. Or a second full panel could be employed, located orthogonally perpendicular to the existing panel.

Introduction of a second panel also could permit the use of color in the display.

• **Other limitations** — Because of EL panel manufacturing limits, the largest display volume presently obtainable is 30 in. wide by 20 in. high.

So far, 15 lines/in. vertically and horizontally appear to be most practical for resolution. Thus, for a display with a range of 300 miles radius a 1.3-mile range resolution is possible; for a 100,000-ft. height display, a resolution of 333-ft. increments and azimuth resolution of about 0.35° are possible. By expanding the scales, these figures could be improved.

Slip-ring life, according to Coddington, also is a limiting factor with the present state of the art. Avco engineers assert that with proper preventive maintenance every 1000 hours of operation, the assembly would perform reliably for about 4000 hours.

EL panel life is limited to about 10,000 hours, but the engineers feel that close control of humidity could extend this figure considerably.

• **"2-D" support** — A new two-dimensional display, measuring 15 x 15 x 1 in., is now in development. Resolution for the EL panel will be 10 lines/in. in each direction. Using grid suppression, only the target will be displayed. Up to 32 targets can be shown on each panel, developers say.

With suitable overlays and a series of panels, a large wall display could be produced for greatly expanded area coverage.

A 30-in. high by 19-in. deep solid-state electronics chassis, designed for a standard 19-in. rack, is being built to carry all the necessary data processing equipment for the newer display panel.

Targets will be selected electronically, sequentially, and presented in the proper location through a "random access technique."



ARTIST CONCEPTION of 2-D/3-D Space and Status Display console now envisioned by Avco for command and control centers.



NEW AUTO-SIMULATOR (right), now in final development, will be used to drive the 3-D display (top left) instead of the three manual controls shown on the console below.

The first feasibility model reportedly will be ready by the end of October.

Also envisioned now by the division is a Space and Status Display Console which would employ both 3-D and 2-D displays.

In use, the 3-D unit could present spacecraft position and relative motion; one 2-D display would relate the continually updated status of equipment at all associated ground stations; another 2-D element could serve as a "world" display, presenting the Earth in two dimensions and the status of space vehicles and sites; a third 2-D display also might be added to present the status of major physical parameters of an astronaut.

Data input could be either fully automatic or a combination of automatic and manual insertion.

• **Varied applications**—By its nature, the Avco 3-D display is believed best suited for some form of command and control center, whether it be for aircraft, weapon systems, or for scientific spacecraft. It permits rapid assessment of a situation and the viewer may approach the display from any direction.

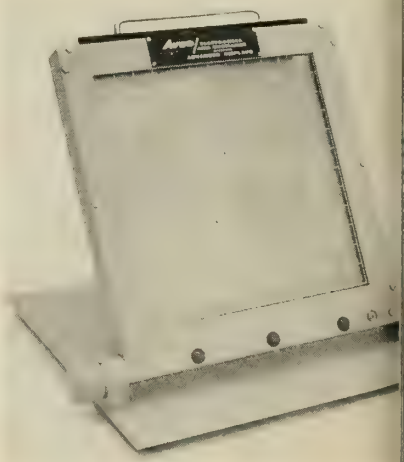
Developers feel the instrument could be adapted readily to perform any of the following functions:

—Spacecraft ground station monitoring for orbital injection or re-entry, particularly for complex maneuvering. (By using perpendicular panels, one could be employed to generate a cone representing a flight corridor.)

—Satellite rendezvous (with automatic readout at ground monitoring stations) or lunar landing trainer. (For the latter, it might also be practical to use a similar display in the lunar vehicle to assist in effecting a landing.)

—Overall surveillance of all or selected Earth-orbiting vehicles or for observance of a multi-vehicle communications satellite system.

—Naval Tactical Defense System. (By employing a plane representing the ocean surface, targets below, on, or above the sea could be displayed simultaneously.) ⁂



2-D DISPLAY will be capable of presenting up to eight targets in each quadrant simultaneously. Panel measures 15x15x1 in.

Stanford Scientists Unveil Newest Adaptive Computer

SEATTLE — A self-organizing adaptive computer designed by Stanford University may represent a major step toward development of a practical "thinking machine."

The new machine was described by Stanford scientists at the August Specialists Meeting of the Institute of Aerospace Sciences in Seattle.

Professors Bernard Widrow and James B. Angell said the machine could solve complex navigation and guidance problems even though one-fourth of its components were malfunctioning.

Missile, satellite and transport experts attending the sessions heard Widrow and Angell describe how "Madaline 1"—a machine that learns like a human—was built in a remarkably short time at the Stanford Electronics Laboratories.

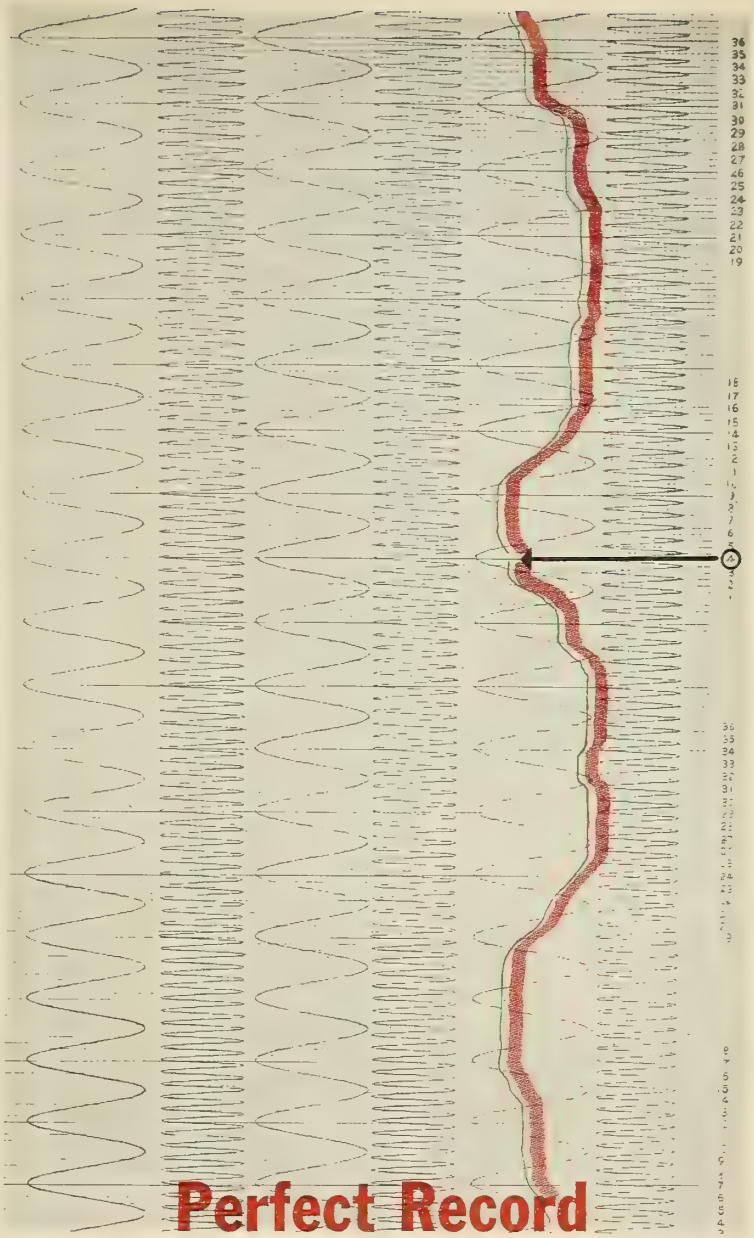
The scientists said what makes Madaline unique is its ability to learn to respond appropriately to a great variety of situations. Thus, a large-scale Madaline might be trained to drive an automobile, type a letter, fly an airplane or perform hundreds of other human-like tasks.

Although a computer can be programed to meet various situation, it must find an exactly matching situation among its stored memory cores. If not, it can't solve a problem. Madaline, however, adapts to new situations, the scientists contended. It can decide which among those situations it has been trained to meet comes closest to the one it faces, and then respond accordingly. In preliminary tests, the machine proved able to recognize speech with 70% accuracy and give 90% correct responses to other stimuli.

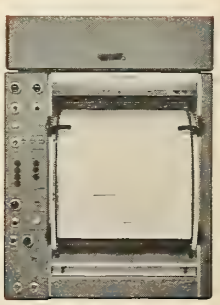
Present Stanford experiments have cast Madaline in the role of a weather forecaster, a computer operator able to take verbal instructions, and a medical diagnostician.

Madaline is composed of six Adalines—adaptive linear nuerons. Adalines are made up either of special memory cores or "memistors"—electrochemical resistors with memory. The present Madaline system uses 102 memistors.

Information introduced into Madaline is recorded in varying degrees of positive or negative charge applied to the memistors, Widrow explained. After this process is repeated with variations a number of times, the machine "learns" the general pattern of the information in much the same way a human does. ⌗



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New Industry Facilities

Sharply increasing sales of its advance PCM telemetry and space communications equipment have accelerated expansion at Telemetrics, Inc., a subsidiary of Technical Measurement Corp., North Haven, Conn. . . . *Kaynar Mfg. Co., Inc., producer of light-weight metal fasteners for the aerospace and other industries, is now in full production in its new facility at Fullerton, Calif., after a move of all personnel and equipment from its Pico Rivera plant.* . . . McDonnell Aircraft has begun work on a new $21 million space center to be integrated with its St. Louis plant. The *Mercury* and *Gemini* prime contractor's added facility will include nine space environmental simulation chambers, one large enough to test *Gemini* complete with its equipment module. . . . *Airtek Dynamics, Inc., Compton, Calif., manufacturer of precision components, pressure vessels, and tankage for aerospace applications, has a $3-million backlog of orders, and expansion is in the offing. The company recently received a commitment from two small business investment companies for investment of $500,000 in Airtek's mushrooming operations.* . . . Formation of a new aerospace division has been announced by American Brake Shoe Co. The new unit was formed by consolidating the Kellogg and Raymond Atchley divisions, west coast-based operations specializing in hydraulic components and systems. Headquarters will be at the Oxnard, Calif., plant.

Several Decades in Sound

One of the best recent promotion efforts is a give-away long-playing Space Age album offered by Raybestos-Manhattan, Inc. The album's sounds—which range from the purring of a Nieuport with an Hispano engine to the space chatter of *Sputnik I*, from the moving "Day of Infamy" speech by Franklin D. Roosevelt to the rantings of Adolf Hitler, from the roar of the *X-15* and missile blastoffs to the lonely wail of a steam locomotive's whistle—is a worthwhile addition to the record library of anyone in the industry. Rudy Vallee, Mrs. Robert Hutchings Goddard, Bing Crosby, Winston Churchill, Laika, an *Atlas* countdown, Alan Shepard during re-entry, a London air raid, the Hindenberg disaster, King Edward VIII, a *Nike-Ajax* blastoff, German Messerschmitts, and a GE scientist bouncing his voice off the Moon, tumble over each other in a cacophony of 75 separate sounds that faithfully record this generation's progress into space. For a complimentary album, address Raybestos-Manhattan, Inc., Passaic, N.J., on your letterhead.

International News Briefs

British Aircraft Corp. and Svenska Radio AB have purchased the Bristol Aeroplane Co. share in Svensk-Engelsk Aero-Service AB of Stockholm. Name of the firm will become British Scandinavian Aviation AB. It will continue as Swedish representative of BAC and other companies. BAC supplies large quantities of *Bloodhound* missiles to Sweden. . . . *A new 60,000 sq. ft. plant for the International Div. of Lear Siegler, Inc., is now under construction near Munich, Germany. The expansion of the recently merged firms was announced in conjunction with relocation of headquarters of the company's international operations from Geneva to Paris.*

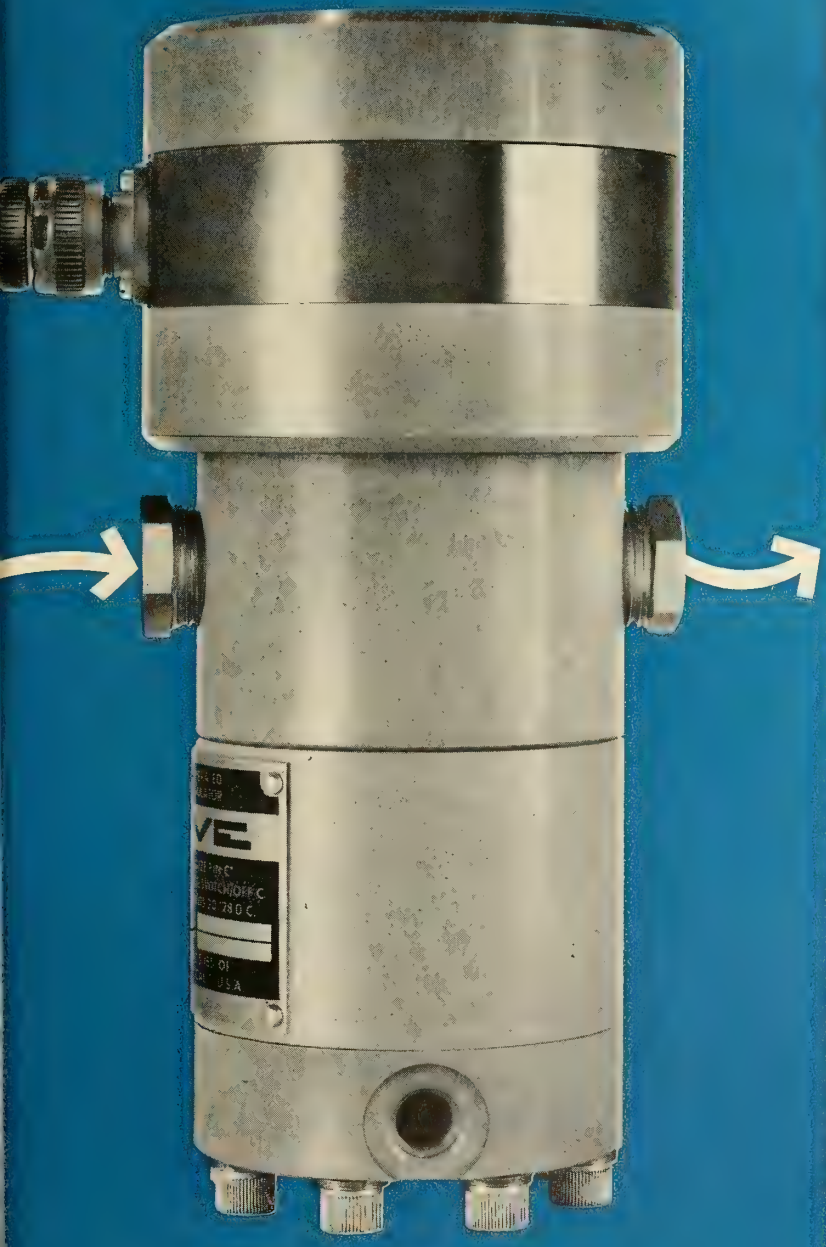
Mergers and Acquisitions

Hewlett-Packard Co., Palo Alto, Calif., designer and manufacturer of electronic measuring instruments, and Neely Enterprises, North Hollywood, Calif., electronic sales representative firm, have announced an agreement whereby Neely will become an affiliate of Hewlett-Packard through an exchange of stock. The agreement is scheduled to become effective Nov. 1. . . . *Litton Industries, Inc., will acquire the privately held McKiernan-Terry Corp., Harrison, N.J., for an undisclosed amount of common stock. McKiernan-Terry, shooting for a $15-million FY '63 sales volume, manufactures radar antenna and sonar equipment, ship stabilizers and similar hydraulic and heavy precision mechanical equipment.* . . . Electronic Specialty Co., Los Angeles supplier of equipment for space conditioning, microwave communications, electronic controls and advanced weapons systems, will acquire Statham-Swearingen, Inc., for an undisclosed amount under the terms of a recent agreement. The latter firm is a pioneer in development of a new gas-fired double absorption chiller that has been described as a "breakthrough" in the air conditioning and cooling field.

Trends and Forecasts

Lockheed Missiles & Space Co., Sunnyvale, Calif., over the past 2½ years has subcontracted 60% of the funds received from its military programs. Small businesses have received a steadily increasing share of this work. . . . *Dyna-Therm Chemical Corp., Beverly Hills, Calif., says it has developed a new family of materials combining thermal and nuclear radiation protection that are expected to have wide application in nuclear radiation fields. The new materials include compounds of boron and lead dispersed in various epoxy, polyurethane and silicone binders, have the same shielding capability as boron and lead, and can be cast, molded, poured, sprayed or brushed.* . . . The first set of stainless steel honeycomb panels for NASA's *Apollo* spacecraft have been ordered from Aeronca Mfg. Corp., Middletown, Ohio, by North American Aviation. Eleven major contracts exceeding $124 million have been awarded in the *Apollo* program, in which more than 2000 firms are ultimately expected to participate. . . . *The last of some 700 Bomarc anti-aircraft missiles built by Boeing for the Air Force rolled off the production line last month, just about 10 years after the first flight of a shell prototype. Delivery will continue to nine Bomarc bases—eight in the U.S. and one in Canada—as the operational units can process them into shelters.*

NEW! REMOTE SERVICE RAPID CHARGE & VENT GROVE LOADING REGULATOR





SIMPLE CIRCUIT—only three wires required to connect new Grove model 17 reducing and relief regulator to your control panel switches. The regulator's two 24 volt DC solenoids are actuated by two switches—one for load, one for vent.

INSTANT RESPONSE—designed for rapid programming of the reference pressure in gas loaded dome regulators. The model 17 loading regulator operates on the same principle, with both the reducing and relief functions controlled by a mutual reference pressure.

VENT PORT—provided for attachment of line to conduct away gas discharged from dome during venting operation.

FAIL-SAFE—upon malfunction of electrical system, the Grove model 17 loading regulator automatically vents downstream to zero pressure.

MODEL 17 Grove loader is rated to 6,500 pound maximum inlet pressure, adjustable to 6,000 pounds on the control side. Body and dome are anodized aluminum, trim is 18-8 stainless steel. Main and relief diaphragms, nitrile rubber. All nylon valves. End connections, ¼" AND 10050-4 or to suit your needs. Write for data sheet.

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WALWORTH GROVE ALOYCO

sales division of Walworth Company

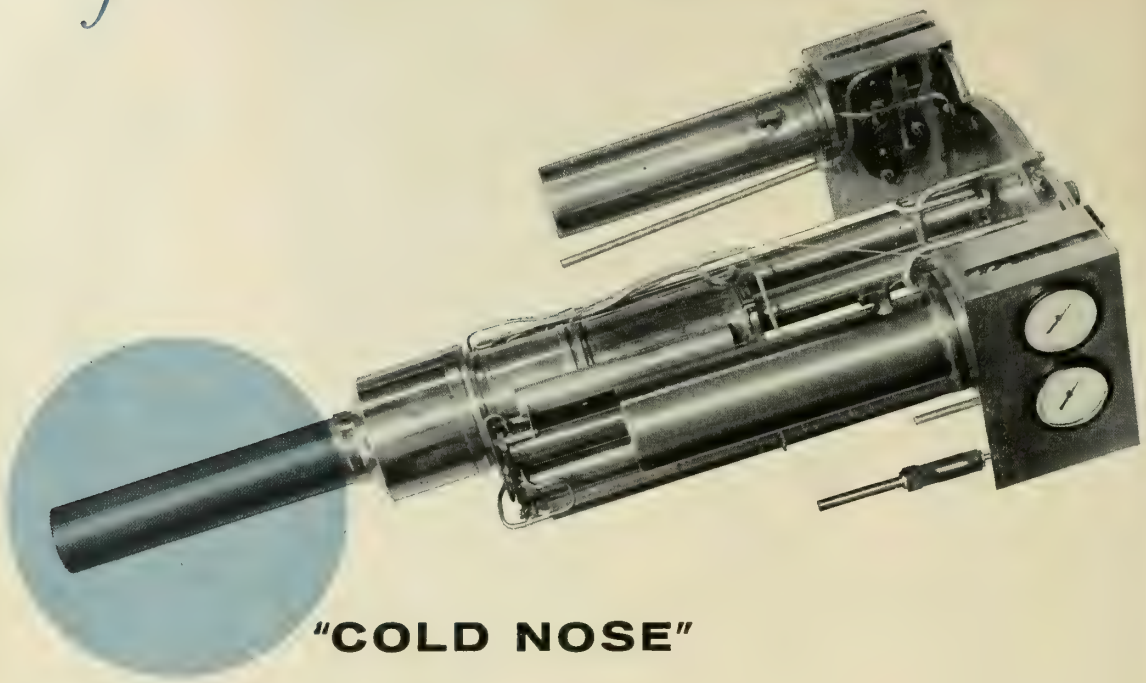
6529 Hollis Street, Oakland 8, Calif.

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"COLD NOSE"

The "cold nose" of this Air Products cryostat has achieved near-absolute-zero environments as low as 2.5°K (−455.2°F). Cryostat pictured is part of an Air Products closed-cycle helium refrigerator developed for Bell Telephone Laboratories under contract with the Army Ordnance Missile Command. The completely self-contained refrigeration system provides maser cooling without need for external supply of cryogenic liquids that boil away in open-cycle systems.

Today, Air Products manufactures a complete line of single- and multi-fluid cryogenic refrigerators. Applications range from the creation of ultralow-temperature environments for space chamber "cryopumping". . . to cryogenic cooling of masers, infrared detectors, superconducting magnets, computer memory planes, and other electronic sensing devices.

Miniaturization of components — pioneered by Air Products — makes possible the application of cryogenic electronics coolers where compactness and light weight are prime requisites. Ability to engineer standard and custom components into "critical-performance" systems gives added flexibility in meeting specialized requirements of industry and government customers.

Customers benefit, too, from Air Products depth of experience in all phases of cryogenics . . . from initial development and design through on-site operations of large-scale cryogenic production facilities.

Whatever your requirements for cryogenic cooling, it pays to contact Air Products first.

Air Products and Chemicals INC.
Allentown, Pennsylvania

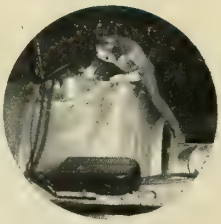
DEFENSE AND SPACE DIVISION



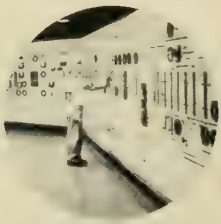
RESEARCH AND DEVELOPMENT



SYSTEMS ENGINEERING



DESIGN AND FABRICATION

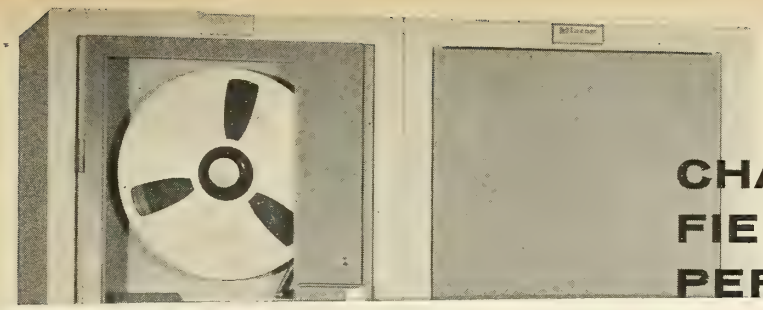


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MISSILES AND ROCKETS
AUGUST 27
1962

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NEW FM RECORDING: ONE CYCLE TO 400 KC

Wideband FM recording using one-megacycle analog techniques—that's the latest exclusive news about the **Mincom CM-114 Magnetic Tape Recorder/Reproducer.** Only with this outstanding field-tested system's 1-mc capability is it possible to record and play back FM signals from 1 cps to 400 kc. Advantages: Extended low frequency response, excellent linearity, seven or fourteen FM recording tracks, dropout reduction virtually to zero. This FM performance can also be added to existing CM-Series systems. Write today for details and complete specifications.

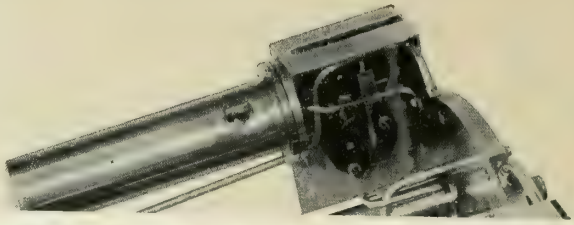
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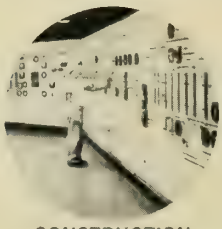
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SYSTEMS ENGINEERING

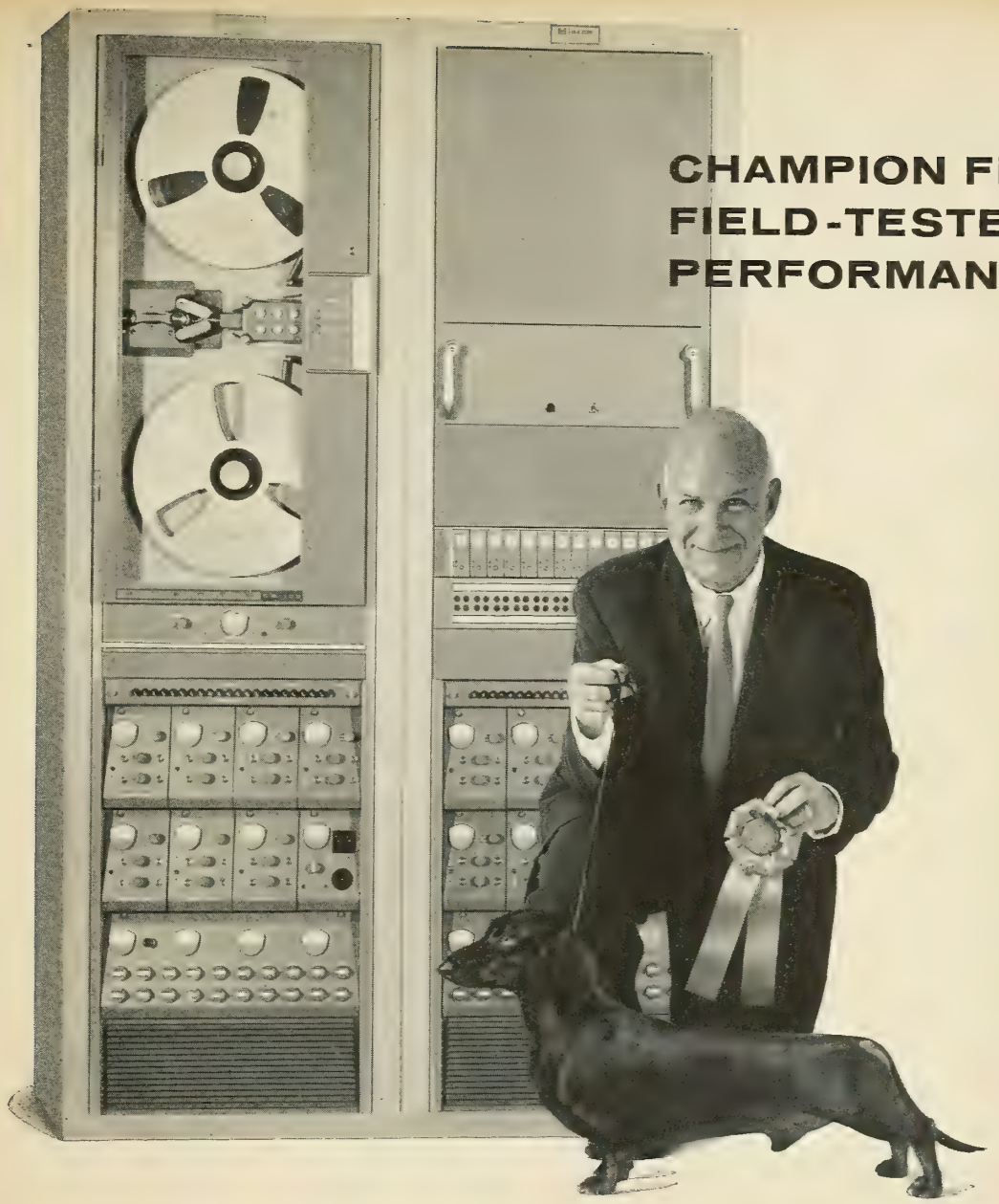

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Wideband FM recording using one-megacycle analog techniques—that's the latest exclusive news about the **Mincom CM-114 Magnetic Tape Recorder/Reproducer.** Only with this outstanding field-tested system's 1-mc capability is it possible to record and play back FM signals from 1 cps to 400 kc. Advantages: Extended low frequency response, excellent linearity, seven or fourteen FM recording tracks, dropout reduction virtually to zero. This FM performance can also be added to existing CM-Series systems. Write today for details and complete specifications.

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Opportunities now open for Senior Research Engineers and Scientists.

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REQUESTS FOR BIDS
GENERAL PROCUREMENTS

Directorate, Procurement and
Production (SAPOS)
Kelly Air Force Base, Texas

6125-796-7607 (P/N 591HC27-5-450-150-1-3) Power supply transistorized 100 each, applicable to McDonnell P/N MDE332-45-301 missile simulator recorder. No drawings or specs are available. Deliver: Transportation Officer, Kelly AFB, Tex.—RFP SA-62-6125-A24998 (Q)—RFP due date 9 Sept. 1962. Items identified by Arnold Magnetics Co., Culver City, Calif. Part numbers. Direct inquiries to Gene Krause, WAlnut 3-5411, Ext. 5203, Kelly AFB, Tex. Note: Select source procurement. Request for proposals will be issued to the following firm: Curtiss-Wright Corp., Wright Aeronautical Div., Wood Ridge, N.J. It is suggested that small business firms and others interested in subcontracting opportunities in connection with this procurement make direct contact with the above firm. 2810-830-1918-PB (P/N 432725) housing machinery and studding assembly., 29 each. Applicable R3350-91-93 engines. No drawings or specifications are available. Deliver: Transportation Officer, Kelly AFB, Tex.—Contract AF 41(608)-13172, Call No. 123-SA-AF.

Purchasing Office
Range Procurement Division (MTDRC-5)
Air Force Missile Test Center
Patrick Air Force Base, Fla.

Procurement of seven type "C" Azusa transponders designed and developed by General Dynamics/Astrodynamics/Astronautics for this equipment. This notice is for information purposes only. RFP not available. A contract is being negotiated with General Dynamics and RFP due date not furnished.

Bureau of Naval Weapons
Washington, D.C.

The Bureau of Naval Weapons contemplates award of a contract to Sperry Gyroscope Co., Div. of Sperry Rand Corp., Great Neck, L.I., N.Y., for the procurement of spare parts, components, assembly units, accessories and manufacturing plant services for the repair, overhaul, maintenance and testing of the AN/SPG-49, AN/SPG-5, AN/SPW-2, computer EX-E and associated test equipment. These equipments are located at U. S. Naval Ordnance and missile test facility, White Sands Missile Range, N.M., This notice is made solely to inform potential subcontractors of the proposed procurement. RFP is not available. Small business firms and others interested in subcontracting should contact the above firm direct referencing CN 0422-63. BuWeps Synopsis No. 38-63.

The bureau of Naval Weapons contemplates award of a contract to Western Electric Co., 3300 Lexington Road, Winston-Salem, N.C. for weapons direction equipment MK 1 MOD O and associated items for *Tartar* guided missile system. This notice is made solely to inform potential subcontractors of the proposed procurement. RFP is not available. Small business firms and others interested in subcontracting should contact the above firm direct referencing CN 0201-63. BuWeps Synopsis No. 34-63.

Aerospace Procurement Div.
Subsystems Procurement Br.
Norton AFB, Calif.

Guided missile components in support of the SM 68 *(Titan I)* missile systems (1) MBAE 1430-712-2539, P/N 207178 noun network mfg. code 90536, 7 each—(2) MBAE-1430-712-1136, P/N 207106 noun network mfg. code 90536, 84 each—(4) MBAE 1430-767-0111, P/N 207138, noun network mfg. code 90536, 2 each—(5) MBAE, 1430-712-2537, P/N 1430-804-1670, P/N 208448, noun drawer assembly mfg. code 90536, 6 each—RFP 04-607-63-128—Items being procured on this RFP were developed and produced by Univac Div., of Sperry Rand Corp., Univac Park, St. Paul 16, Minn. Drawings, engineering data, specs and copies of RFP not available through Air Force channels for distribution. Negotiations for services being conducted with Univac Div. of Sperry Rand Corp., Univac Park, St. Paul 16, Minn. Any inquiries relating to subcontracting opportunities should be made directly to the above contractor.

Supply Officer
U.S. Naval Research Laboratory
Washington 25, D.C.

Transmitters, transistorized, telemetry, satellite borne; single frequency, crystal controlled, VHF range; sine wave amplitude modulated; input from 11 to 13.5 VDC either polarity; to be of minimum volume and weight; to have utmost reliability under satellite environments—1 each—to be in accord with NRL specs forwarded with the RFP—Deliver to: U.S. Naval Research Laboratory, Washington 25, D.C.—various quantities—RFP 163/N80451/63Q—RFP due date 25 Sept. 62. Requests for copies of this requirement should be received in writing no later than 4 Sept. 62.

Navy Purchasing Office
4th and Independence Ave., S.W.
Washington, D.C.

The following items are procured under IFB 600-224-63—bid opening 18 Sept. 62. Containers, rocket, MK 37, MOD 0—Specs: LD No. 26901-MK37-Mod 0—quantity 2793 each—Lot 2, same—quantity 570 each.—Destinations to be furnished at a later date—(An additional quantity of 9804 each is being reserved for firms in labor surplus areas under partial set-aside. If the total requirements of the partial set-aside cannot be filled by awards to firms in labor surplus areas, negotiations for the remaining requirements of the partial set-aside may be conducted with eligible small business concerns outside labor surplus areas.)

SOLID ROCKET ENGINEERING AT
AEROSPACE CORPORATION

Positions are available at Aerospace Corporation in Southern California which will provide highly qualified professional engineers with the opportunity to associate with the country's most knowledgeable experts in the field of rocketry. Those selected will have an opportunity to influence the course of development of a new technology.

Successful applicants will be required to perform analysis, preliminary design, design review, and project engineering in programs permitting professional growth into space vehicle system aspects of solid rocket applications.

Candidates for these positions should have acquired broad design and analysis experience in solid rocketry with particular specialization in one or more of the following:

- Case, nozzle and insulation design and materials
- Propellant properties, processing and performance
- Grain design and interior ballistics
- Test operations, instrumentation and data reduction
- Nozzle design, gas dynamics and heat transfer
- Quality assurance, process inspection and non-destructive testing
- Handling and ground support equipment
- Combustion instability and detonation behavior
- Vehicle system integration

Openings exist for engineers, preferably with advanced degrees, whose minimum of ten years of professional engineering experience includes at least five years of successful employment in the solid rocket industry.

Qualified applicants are invited to contact Aerospace Corporation, an equal opportunity employer. Write to Mr. Charles Lodwick, Room 305, P.O. Box 95081, Los Angeles, California.

AEROSPACE CORPORATION

Organized in the public interest and dedicated to providing objective leadership in the advancement and application of space science and technology for the United States Government.

AWARDS

AIR FORCE

$21,361,049—**Martin Marietta Corp.,** New York City, for production of followon *Titan II* missiles and related equipment (supplemental contract).

$12,803,651—**Hercules Powder Co.,** Wilmington, Del., for research and development work on Stage III *Minuteman* motors.

$10,700,000—**Douglas Aircraft Co.,** Santa Monica, Calif., for research and development work on the *Skybolt* weapon system (supplemental contract).

$8,308,000—**General Electric Co.,** New York City, for work on space vehicles (2 contracts).

$6,610,000—**North American Aviation, Inc.,** Los Angeles, for development of the *Minuteman* guidance and control systems (supplemental contract). Work to be done at Downey, Calif.

$4,300,000—**Raytheon Co., Missile and Space Div.,** Bedford, Mass., for RAMPART (Radar Advanced Measurements Program for Analysis of Re-entry Techniques) installation at White Sands Missile Range.

$3,000,000—**Lockheed Aircraft Corp.,** Burbank, Calif., for work on space subsystems (2 supplemental contracts). Work to be done at Sunnyvale, Calif.

$2,800,000—**Radio Corp. of America,** New York City, for provision of final stage vehicles in support of the space program. Work to be done at Burlington, Mass.

$2,400,731—**Martin Marietta Corp.,** New York City, for installation and checkout of *Titan* missile complexes. Work to be done at Ellsworth AFB, Rapid City, S.D.; Mt. Home, AFB, Mt. Home, Idaho; Larson AFB, Moses Lake, Wash.; and Beale AFB, Marysville, Calif.

$1,907,000—**Douglas Aircraft Co.,** Santa Monica, Calif., for provision of a fuze capability for the MB-1 *Genie* rocket.

$1,700,000—**Minneapolis Honeywell Regulator Co.,** Minneapolis, Minn., for work on the *X-20 (Dyna-Soar)* primary guidance system (supplemental contract). Work to be done at St. Petersburg, Fla.

$1,205,198—**Martin Marietta Corp.,** New York City, for design study of a standardized space launch vehicle. Work to be done at Denver, Colo.

$1,000,000—**General Precision, Inc., Kearfott Div.,** Little Falls, N.J., for the development, fabrication and installation of a celestial-inertial complex at Holloman AFB, N.M.

United Technology Corp., Sunnyvale, Calif., for development of an advanced high performance solid rocket propellant (undisclosed amount).

NAVY

$41,000,000 — **North American Aviation, Inc.,** Downey, Calif., for production of 39 Autonetics-built ship's inertial navigation systems (SINS) to be installed on 10 Lafayette-class *Polaris* submarines.

$2,686,310—**Maxson Electronics Corp.,** New York City, for work on *Bullpup* missiles. Work to be done at Old Forge, Pa.

$1,578,000—**Fairbanks, Morse & Co.,** Yonkers, N. Y., for diesel equipment for 6 *Polaris*-firing nuclear submarines and 2 U.S. Navy patrol escort vessels.

NASA

$999,987 — **General Dynamics/Astronautics,** San Diego, Calif., for detailed system definition and Preliminary design of giant *Nova* space vehicles to carry heavy payloads into Earth orbit to the Moon and the planets.

The Garrett Corp., AiResearch Div., Phoenix, Ariz., for building fueling valves for the *Saturn C-5* launch vehicle (undisclosed amount).

Republic Aviation Corp., Farmingdale, N.Y., for studies of an advanced orbiting solar observatory.

Electronic Communications, Inc., Research Div., Timonium, Md., for a satellite antenna study involving the investigation of the properties of radiating elements, development of an optimum array design and calculation of the performance to be expected for various satellite configurations (undisclosed amount).

Aeronca Manufacturing Corp., Middletown, Ohio, for a set of stainless steel honeycomb panels for the *Apollo* spacecraft (undisclosed amount).

Ford Bacon & Davis, Inc., New York City, for directing the design of an advanced flight accelleration facility to be used in connection with the manned space flight programs (undisclosed amount).

INDUSTRY

$1,981,965—**Hayes International Corp.,** Birmingham, Ala., from **Chrysler Corp.'s Space Div.,** for manufacture of booster components for the *Saturn C-1* space vehicle (supplemental contract).

$554,000 — **Consolidated Electrodynamics Corp.,** Pasadena, Calif., from **Western Development Laboratories, Philco Corp.,** for electronic equipment to be installed at Air Force tracking stations to record telemetered data from satellites.

$469,000—**U. S. Science Corp.,** Los Angeles, Calif., from **Aeronautical Systems Div.** (both subsidiaries of United Industrial Corp.) for production of pre-flight testers.

Collins Radio Co., Dallas, Tex., from **McDonnell Aircraft,** for voice communications systems for the *Gemini* two-man spacecraft (undisclosed amount).

Pittsburgh-Des Moines Steel Co., Pittsburgh, Pa., from **McDonnell Aircraft Co.,** for design, fabrication and erection of a space simulator chamber to be used in the *Gemini* space program.

COUNTDOWN ON RELIABILITY

Reliability typifies the Stearns-Roger staff of specialists in the fields of missile, cryogenic and nuclear facilities. Reliability requires the dedicated services of experienced and competent engineering personnel in the areas of criteria development, design, procurement, installation, check-out and operation.

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THE PRACTICAL MEN

An idea is born.

It could lead to a great scientific accomplishment. It could even create a new technology.

But first it must achieve reality. To do this it must leave the theorist and go to another kind of man, a man with a more practical bent of mind.

This is the challenge for creative engineers and modern management: to turn ideas into realities. And today this work is more difficult than ever before.

For now the aerospace industry is called upon to engineer space ships that will travel thousands of miles from earth and return. It is called upon to develop rocket engines with the power of a million automobiles. It is called upon to produce electronic equipment that will last thousands of hours... to design antenna systems that can listen to stars billions of miles away... to produce electricity by nuclear power with increasing efficiency.



Even while you are reading this, the engineers of the aerospace industry are working toward these objectives. They are creating functional ideas from broad theories. They are searching out the exact materials, equipment, systems, and components to suit their needs. Often in this search they must create their own answers.

Steadily, piece by piece, part by part, the finished whole begins to emerge. The prototypes are examined. Tests run. And finally the new system is complete—tested, proved, ready to use.

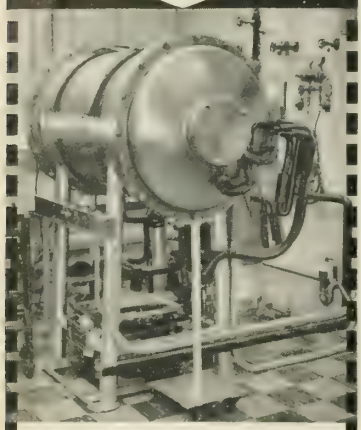
This is the work of men who turn ideas into reality. This is the work of men who are creating the products of tomorrow and the industries of the future.

This is the work of the practical men.

North American Aviation is at work in the fields of the future through these six divisions: Atomics International, Autonetics, Columbus, Los Angeles, Rocketdyne, Space & Information Systems.

THIS ILIKON SYSTEM SIMULATES SPACE UP TO 1000 MILES FOR

RAYTHEON



In continued operation at Raytheon's Missile and Space Division, this 20 cubic foot Space Simulator produces a pressure below 2×10^{-10} mmHg. a pressure **guaranteed by Ilikon** in all of their ultra-high vacuum systems, regardless of size

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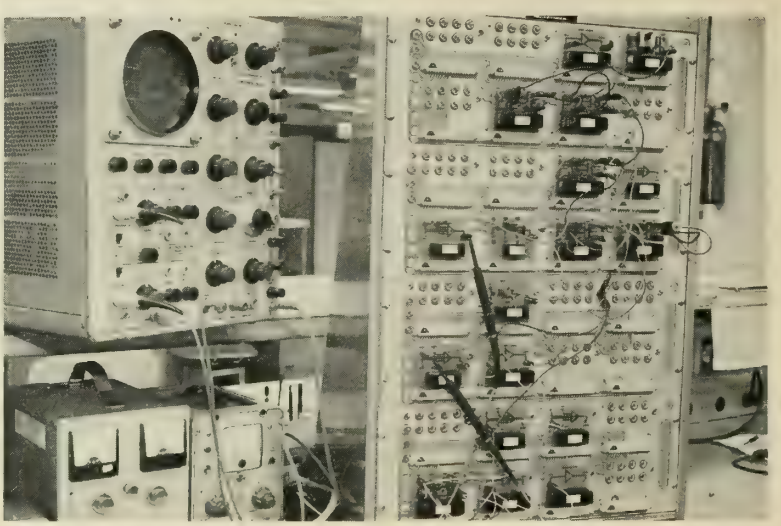
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ILIKON

Circle No. 26 on Subscriber Service Card



New Product of the Week:

Digital Logic Breadboard

A CONVENIENT, time-saving kit which facilitates breadboarding of digital logic systems has been developed by the Martin Co.'s Electronic Systems and Products Division.

The kit consists of four 7x19 in. patchboards mounted in a standard 32-in. table rack, and an assortment of the most frequently used standard Martin digital logic modules. A series of 20 compatible digital logic modules is available, covering most digital logic functions. For kit use, the modules are supplied mounted on printed circuit boards which adapt them to the patch panels. A power supply may be included as optional equipment.

Circle No. 225 on Subscriber Service Card

Visible Light Laser

A visible-light continuous-wave laser is now being marketed by the Perkin-Elmer Corp. and Spectra-Physics, Inc. The unit is a helium-neon gas phase laser emitting a continuous bright red beam of coherent visible light at a wavelength of 6328 angstroms.

Circle No. 226 on Subscriber Service Card

Transistor Noise Analyzer

An instrument designed specifically for analysis of electrical noise generated by low-collector-current devices, such as planar epitaxial transistors, is available from Quan-Tech Lab., Inc.

The Model 311 provides a three-point spectrum analysis of noise (at 100, 1000, and 10,000 cps) simultaneously, enabling identification of the portion of the total noise that follows the 1/f relationship (noise power inversely proportional to frequency.)

The unit also measures I_{cbo} and I_{ebo}. The collector current range is from 5 to 1000 microamperes, and the collector voltage range is from 0.1 to 30 volts.

Circle No. 227 on Subscriber Service Card

Data Quality Monitors

Atlantic Research Corp. has available a series of DQM Data Quality Monitors. Whenever the signal deteriorates in a circuit, the DQM assigned to that circuit automatically alerts the operator to correct the condition before the subscriber complains.

Covering 60 to 150 words per minute, a wide range of distortion thresholds may be selected by a simple screw adjustment. In addition to distortion alarms, the on-line-monitor will announce an open line or a no-signal condition.

Circle No. 228 on Subscriber Service Card

Angle Measuring Instrument

Designed for direct application in the ground support equipment, servo and control system fields, the Angle Measuring Instrument, available from Micro Metrics, Inc., provides both high absolute accuracy of ± 6 min. and ultra-high precision in repeatability (± 36 sec.), sensitivity (36 sec.), and resolution (36 sec.). Model 210 can be

used as a servo null indicator, absolute angle measuring device, transducer readout display, remote shaft position display, and trigonometric converter.

Circle No. 229 on Subscriber Service Card

Portable Oxygen System

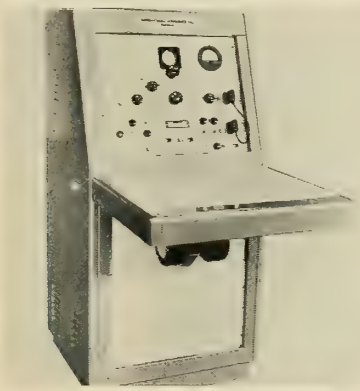
Addition of a carrying case for the Zep-O-Life portable oxygen system which makes the equipment immediately available for use has been developed by Zep Aero.

The system provides more than 1½ hours of oxygen without the use of regulators, hoses or manual valves. Operation is instantly controlled by facial contact.

Circle No. 230 on Subscriber Service Card

Ultrasonic Generator

The continuously tunable frequency output range of its 250-watt broadband ultrasonic generator is being marketed by International Ultrasonic, Inc.



The generator is available with an optional 20-30 oscillator with automatic frequency control, in addition to the broadband oscillator, and another option provides for output in pulses from 1 to 100 microseconds wide at the rate of 10 to 500 pulses per sec.

Circle No. 231 on Subscriber Service Card

Waveguide Test Equipment

Waveline, Inc. is marketing an extensive and complete line of WR-229 Waveguide Test Equipment for use over the frequency range of 3.30 to 4.90 Gc.

This series of test equipment includes such items as waveguide to coaxial adapters; variable and fixed attenuators; phase shifters; fixed and turnable crystal mounts; waveguide elbows; straight sections and twists; fixed and adjustable terminations; series shunt and hybrid tees; slide screw and hybrid tuners; adjustable shorts; pressure units; broadwall and crossguide couplers; waveguide shorting switches and transitions.

Circle No. 232 on Subscriber Service Card



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The ASTRONAUTICS RESEARCH OFFICE now has three Branches—Astronautics Defense, Measurement Satellites and Observation Satellites—and is responsible for establishing requirements and specifications, controlling schedules and budgets, conducting applied research studies, feasibility tests and evaluations of Naval efforts in space research.

Because the Office is small, and the scope of responsibility so vast, these are excellent ground-floor opportunities for engineers with a strong background in physics, aerodynamics, electronics and mathematics, to become thoroughly conversant with the nation's space research work . . . to make a name for themselves . . . and to move up as the Office grows.

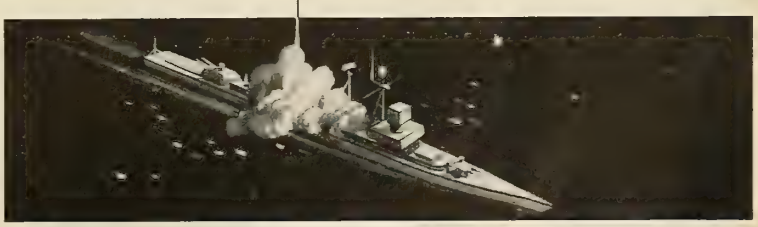
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1
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5

Last night in Antarctica, nuclear power

1 lit the bulb
2 heated the room
3 fried the eggs
4 boiled the coffee
5 kept the scientific instruments running
6 burned the toast

Antarctica's first nuclear power plant is now operating. It supplies all the electricity for the 1000 men stationed at the Navy's McMurdo Sound Research Base.

The heart of the plant is an extraordinary metal cylinder that helps turn nuclear energy into electricity. The cylinder is only 3 feet high and 2 feet in diameter, yet it does the job of millions of gallons of ordinary fuel oil. It delivers 1500 kilowatts and has to be replaced only once every 2-3 years.

Because nuclear energy packs great power in little space, it's extremely useful when you need electricity in remote spots. It's portable and gives you power that lasts for years.

Take outer space. Right now a tiny nuclear generator is spinning around the earth aboard the Navy Transit Satellite System. It runs many of the instruments, can keep them running for at least 10 years.

Near both poles of the earth, small atomic generators are being used to power unmanned weather stations.

In Sundance, Wyoming, a nuclear reactor powers a new Air Force radar station. On the Atlantic Coast, the Coast Guard now has its first atomic buoy. On the floor of the Atlantic, a sound beacon for navigation will be atomically powered. Soon a floating nuclear power plant will enable the Army to bring electricity to distressed coastal areas.

Each of these installations was designed and built by the nuclear division of Martin Marietta. Each utilizes portable nuclear power, a form of power that is becoming recognized as one of the most practical known. Portable nuclear power units can carry us to outer space. And some day they may be used for simpler things like frying your eggs.

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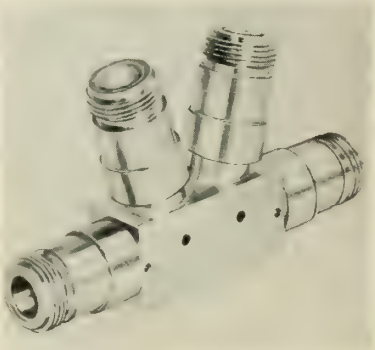


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in two models, are designed for use up to 4000 mc to satisfy a wide range of requirements. The Model CA has both ends of the auxiliary line available for bi-directional signal sampling. The CB line has one end permanently terminated to assure optimum directivity.

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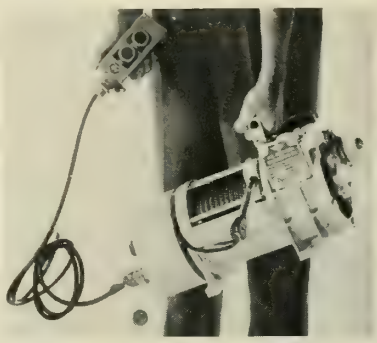
Anechoic Test Range

Budd-Stanley Co., Inc. has available an anechoic test range for antenna measurements in a frequency range from 1 to 40 Gc/s. This range is 40 ft. long. It is completely instrumented for azimuth, elevation and polarization plotting, with both one-way and two-way plot instrumentation available.

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Portable Powerhouse

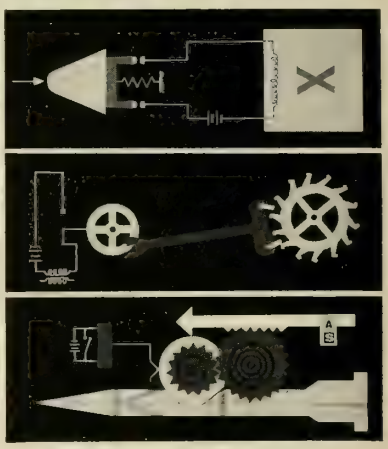
A midget-size winch with instant control and portability in handling materials is offered by All American Engineering Co. The 61-M2 holds 12,000 lbs., lifts 6000 lbs. and is compact—



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UNITED STATES GOVERNMENT:
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INDUSTRIAL SECTION:
Detailed listings of major missile/space manufacturers and leading component manufacturers . . . names, addresses, telephone numbers.

COMPANY REPRESENTATIVES SECTION:
Listing company representatives stationed in Washington and in most strategic missile/space areas.

INTERNATIONAL SECTION:
Covers all countries with missile/space activities, plus all NATO member nations.

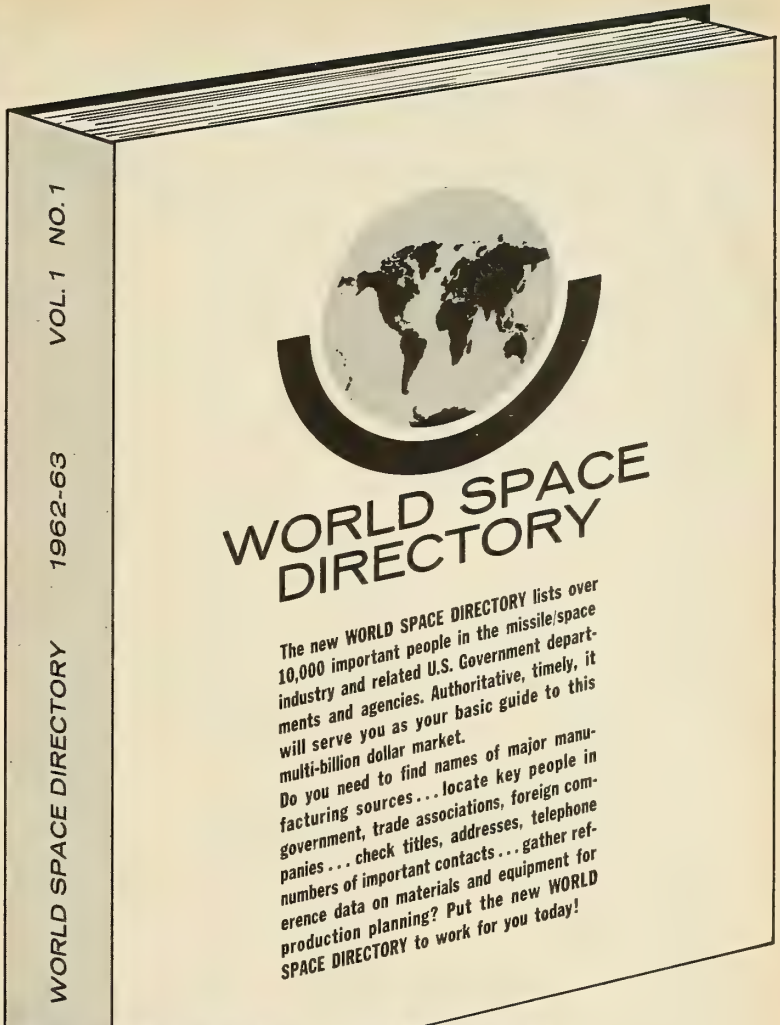
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—names in the news—

Jesse M. Shaver, Jr.: Formerly with Wells-Gardner Electronics Corp., Chicago, joined American Air Filter Co., Inc., Louisville, Ky., as administrative assistant to the president.

G. J. Rauschenbach: Appointed marketing manager of Ford Motor Co.'s Aeronutronic Div., Newport Beach, Calif.

Dr. Peter M. Kelly: Appointed associate director of the Philco Scientific Laboratory, Blue Bell, Pa.

Robert E. McEwen: Named president of FMC S.A., Geneva, Switzerland.

Hubert I. Bennett: Named vice president of McCormick Selph Associates, Hollister, Calif.

John R. Harkness: Named president and chief executive officer of United Control Corp., Redmond, Wash.

Richard W. Harbison: Appointed president of Lear Siegler Services, Inc., Los Angeles.

Karl E. Bauerle: Appointed production coordinator at Dynamic Gear Co., Inc., Amityville, N.Y.

Michael E. Donnelly: Named manager of the newly opened Houston office of the Bendix Corp.

James M. Roche: Elected a director and an executive vice president of General Motors Corp., Detroit.

Sherman M. Fairchild: Elected chairman of the executive committee of Fairchild Camera and Instrument Corp., Syosset, N.Y. **John Carter** named chairman of the board and chief executive officer. **Richard Hodgson** named president.

G. L. Armstrong: Named director of systems integration, General Dynamics Astronautics, San Diego, Calif.

Dan T. Buist: Named president of Turco Products, Inc., Wilmington, Calif. **S. G. Thornbury** will direct all operations of the Purex Industrial and Institutional Products Group.

Dr. Lawrence E. Mertens: Appointed staff scientist of the RCA Service Co.'s Missile Test Project, Patrick AFB, Fla.

Edward F. O'Brien: Named chief engineer for Motorola Aviation Electronics, Inc., Culver City, Calif.

Joseph G. Neuland: Formerly with Beckman Instruments Systems Div., Fullerton, Calif., named marketing vice president of Telemetrics, Inc., Gardena, Calif.

W. Thomas Stark: Appointed aerospace product manager for Cleveland Pneumatic Industries, Inc., Cleveland.

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—when and where—

AUGUST

Third International Congress, International Council of the Aeronautical Sciences, New Congress Hall, Stockholm, Sweden, Aug. 27-Sept. 1.

Second International Congress on Information Processing, International Federation of Information Societies, Munich, Germany, Aug. 27-Sept. 1.

Fourth Electronic Industries Association Conference on Maintainability of Electronic Equipment, sponsored by Engineering Dept. of EIA with cooperation of Dept. of Defense, University of Colorado, Boulder, Aug. 28-30.

Fifth International Congress for Electron Microscopy, sponsored by Electron Microscope Society of America, National Institutes of Health, National Science Foundation, Office of Naval Research, AEC, Office of Ordnance Research and AFOSR/Solid State Sciences Div., University of Pennsylvania, Philadelphia, Aug. 29-Sept. 5.

SEPTEMBER

National Advanced Technology Management Conference, Institute of Radio Engineers, Seattle, Sept. 3-7.

International Symposium on Information Theory, Institute of Radio Engineers, Brussels, Belgium, Sept. 3-7.

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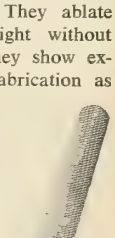
The missile: SIDEWINDER

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Playing with Blocks

IT HAS NOW been made clear what the U.S. will do in response to the new Soviet demonstration of overwhelming superiority in the space field.

Nothing.

Department of Defense has declared on the record that the twin space shots by the Russians have no military significance.

NASA Administrator James E. Webb has stated flatly that we will beat the Russians to the Moon. (This may be considered as remarkable overnight progress, since NASA estimates up to that point were giving us only a 50-50 chance.)

Wernher von Braun says we are on a par with the Russians in the Moon race and have no serious handicaps to overcome.

Former President Eisenhower is fed up with all this talk about a space race and comments: "I don't believe there is a gap between us and them." (Them, presumably, is Russians, not Democrats.)

The entire gamut of remarks has the dreamlike quality of a Soviet propaganda exercise: if we can only manage to ignore the unpleasant things of life, perhaps they will go away.

One eminent U.S. columnist has even explained to his readers that the whole thing may be a Soviet hoax. This does the nation a distinct disservice. So, on the other side, does the exaggeration of the Soviet accomplishment by a supposedly responsible trade journal.

There is sufficient lack of realization at high government levels of the actual facts. There is no need to becloud issues by distorting them at both ends.

Defense Secretary McNamara, supported by his research and engineering aides at the DOD level, states that additional funding is not necessary at this time to increase the pace of the U.S. military space program. This is in direct contradiction to reports we receive from industry. A number of programs can be stepped up simply by additional funding.

Mr. McNamara's DOD team, under cover of an anonymous wire service interview, has made the statement that the Air Force, despite all its talk, has not presented any proposals for space weapons to DOD. Reaction in the Air Force to this statement need not be elaborated.

DOD also has done a great deal of pointing with pride to the *Titan III* liquid-solid space booster program, following its conveniently-timed announcement. Program *624A* is an excellent program but it is not a substitute for other things that should be done.

DOD has not been equally loquacious about its position on a big solid booster program. It has quietly thrown back at the Air Force one proposal for a relatively modest solids development program, demanding that it be even further trimmed to DOD specifications.

The result is a new Air Force proposal which calls for expenditure of less than $100 million over the next two to three years for development of segments of 156-in. and 260-in. solid boosters. This appears to us to be totally inadequate.

Argument for this castrated program is that it can be accomplished without funding additional facilities. It is true that a number of propulsion firms have facilities adequate for such a program—or most of it. But this is like tailoring your requirement for a new car to a set of old bicycle tires you happen to have in the garage.

An adequate and well-financed solid booster program beyond the 120-in. is a must for the nation's military space effort. It is an area in which we have some assurances of a technological lead over the Soviets, a lead which undoubtedly is diminishing with every passing minute.

DOD leaders still are talking fondly of building blocks and a broadly based effort, two terms which seem to enchant them these days. Assistant Secretary John Rubel was on display at WESCON in Los Angeles last week, speaking on "technological building blocks" and the fact that "we have not yet succeeded in defining a military need for man in space."

Will DOD, one wonders, ever define that need? Or will they still be playing with their blocks when the Soviets come marching down Pennsylvania Avenue?

FORTUNATELY, two forces which the Administration has learned to respect are beginning to take an increased interest in the fight.

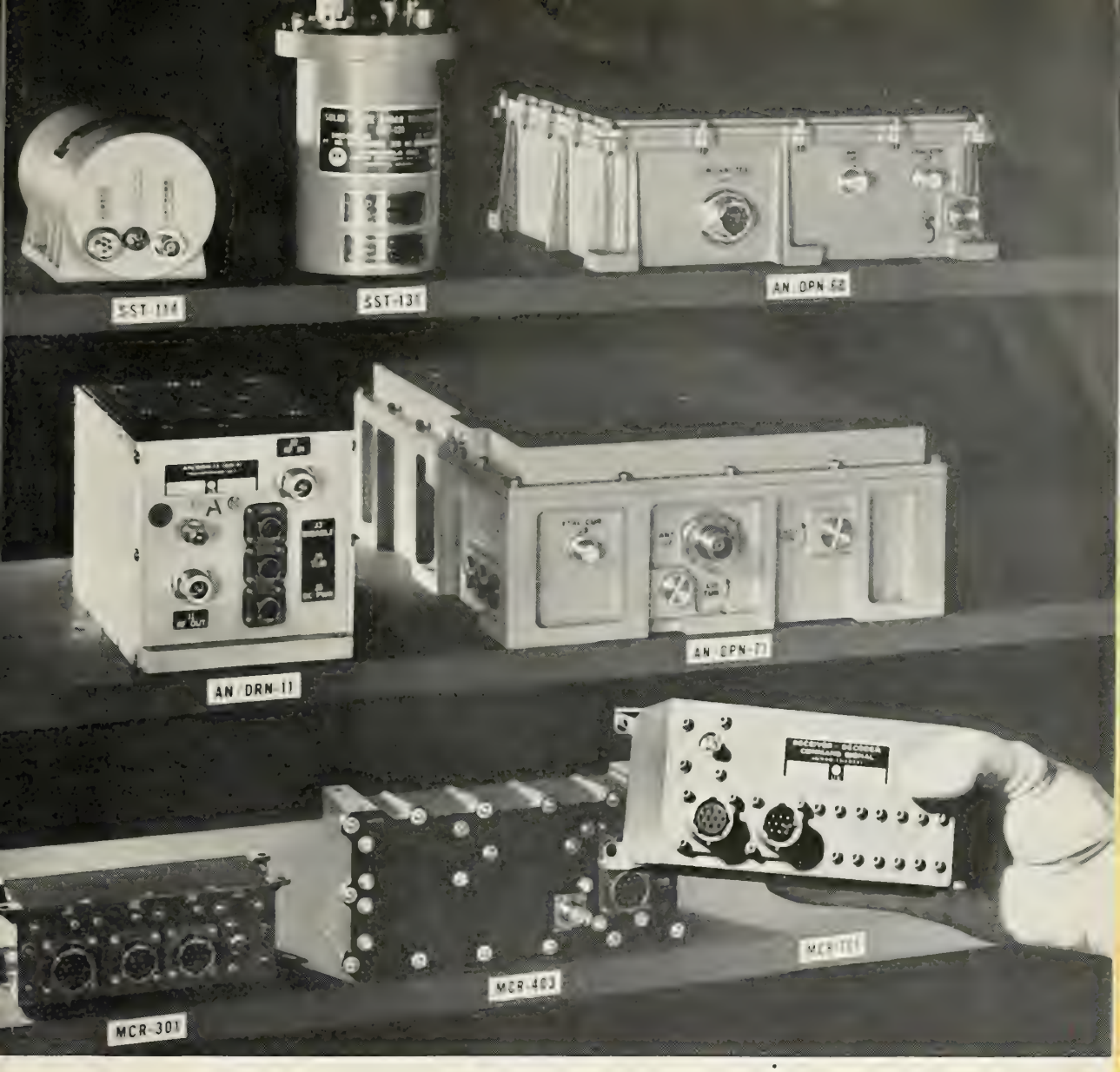
One is Congress, where Senators Goldwater and Cannon are among those most vocally seeking some action. There also are others on the Hill who are concerned, not as outspoken but perhaps more effective.

The other force is the general press. Publications such as the *New York Times, Washington Post* and *LIFE* magazine have taken up editorially the need for a larger military space program.

Thus, the picture is not entirely black. But until DOD shows a clearer understanding of the need for a manned and unmanned military space force to meet the Soviet threat, statements that an inadequate budget will be somewhat better in Fiscal '64 do not fill us with confidence.

The time may be ripe for an Air Force general to do another Billy Mitchell—to prod us into the military space age as we were prodded into the military aviation age.

William J. Coughlin



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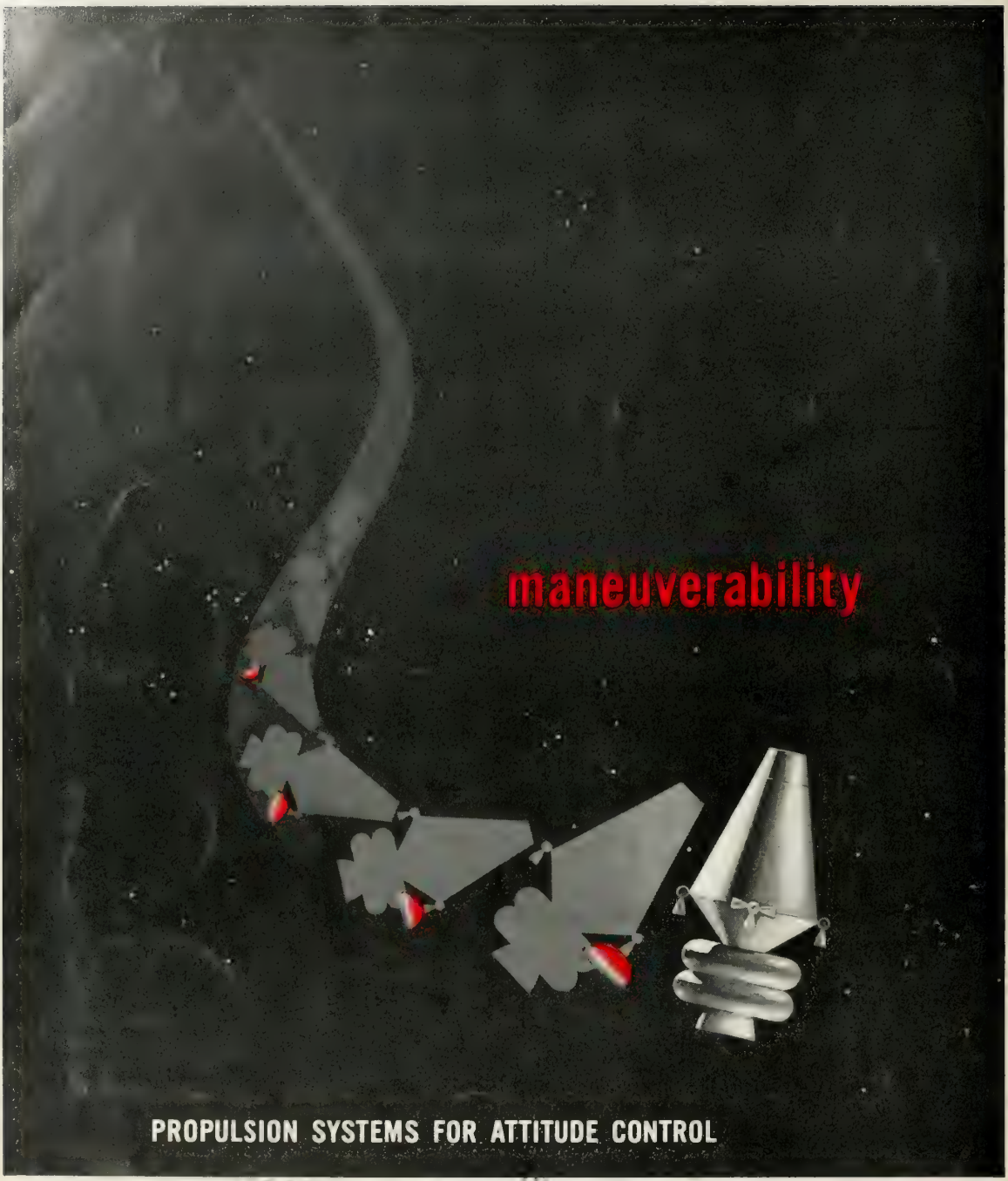
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